Stressor Identification

Dry Run Creek, Iowa

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Watershed Improvement Section
and
Watershed Assessment and Monitoring Section

Iowa Geological and Water Survey

Environmental Services Division

Iowa Department of Natural Resources

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Acknowledgements

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1. Executive Summary

A Stressor Identification (SI) was completed for Dry Run Creek (Segment No. IA 02-CED-0390) located in the city of Cedar Falls (western Black Hawk County). Dry Run Creek flows into the Cedar River. This waterbody is identified on Iowa's (Section 303(d)) list of impaired waters as impaired for aquatic life use, cause unknown. The goal of this SI was to determine the primary causes of biological impairment including any pollutant for which a Total Maximum Daily Load (TMDL) is required.

The first biological assessment of Dry Run Creek (DRC) was conducted in 1992. The assessment discovered evidence of biological impairment, including low abundance of fish and cited a lack of substrate diversity as a factor in the impairment. In 1996 a fish kill, totaling about 60 fish was reported along the impaired segment of DRC. Additional biological sampling conducted in 1999 indicated that reduced biotic condition index levels existed in the stream segment designated for aquatic life uses. Readily available stream data and information about the watershed were assembled and a weight of evidence approach was used to evaluate candidate causes of impairment. The evidence review process considered data for proximate stressors including biological, chemical, or physical agents that directly impact stream biota, and additional data representing intermediary steps in causal pathways that connect stressor sources and biological effects.

Despite some data limitations, the evidence was sufficient to identify the following primary stressors, all of them are capable of causing a biological impairment in the DRC watershed:

- Elevated levels of bedded sediments
- Reduced macro and micro habitat availability
- Excessive storm water inputs and hydrologic alterations

Depending upon the causal mechanism, primary stressors can manifest as short-term acute impacts or long-term chronic impacts to aquatic biota. To restore the biological condition of the stream to unimpaired status, the TMDL and implementation plans need to address each of the primary stressors and multiple causal pathways that occur in the watershed.

2. Introduction

This Stressor Identification (SI) for Dry Run Creek (305b Segment No. IA 02-CED-0390) has been completed to identify the causes of biological impairment including any pollutants a Total Maximum Daily Load (TMDL) can address.

A major goal of this SI was to determine whether the impairment was caused by a pollutant (e.g., ammonia) or a non-pollutant type of stressor (e.g., channelization); a non-pollutant stressor would not require a TMDL. Regardless of the cause a complete SI identifies all causal agents and pathways responsible for impairing the aquatic biological community.

2.1 Watershed Features

The surface watershed of DRC is located near the center of the Iowan Surface ecoregion (**Figure 1**). The Iowan Surface (47c) ecoregion is a geologically complex region located between the bedrock-dominated landforms of the Paleozoic Plateau region and the relatively recent glacial drift landforms of the Des Moines Lobe (Prior 1991; Griffith et al., 1994). The southern and southeastern border of this ecoregion is irregular and crossed by major northwest-to-southeast trending stream valleys. In the northern portion of the region, glacial deposits are thin and shallow limestone bedrock creates karst features such as sinkholes and sags. There are no natural lakes of glacial origin in this region, but overflow areas and backwater ponds occur on some of the larger river channels, providing diverse aquatic habitat and a large number of fish species.

At the confluence with the Cedar River in Cedar Falls, DRC is a third-order stream draining 15,248 acres in western Black Hawk County (**Figure 2**). Current land use in the watershed is a mix of agriculture and urban. Row crop agriculture dominates the landscape in the upper portions of the watershed. Most of the first order tributaries contain agricultural land in the riparian corridor (**Figure 3**). Roughly 55 percent of the watershed is currently utilized for row crop agriculture and 4 percent is used as grazed grassland. The central and lower portions of the watershed have been urbanized over the past 100 years with the growth of the Cedar Falls area. Based on the 2002 land cover data 22 percent of the watershed is in urban land use and more than 9 percent of the watershed surface is impervious. Urbanization in the central portions of the watershed was especially rapid over the last decade (**Figure 4**). Urban development in the DRC watershed was determined on a yearly basis utilizing GIS information from the Black Hawk County assessor's office. Certain areas of the watershed have experienced a 200 percent increase in urban land use over the last decade. Sub-watersheds "4" and "8" along the southeastern branch of DRC have the highest percent increase in the watershed over the past decade. This increase is due in large part to the rapid expansion of an industrial park and several housing developments at the edge of city limits.

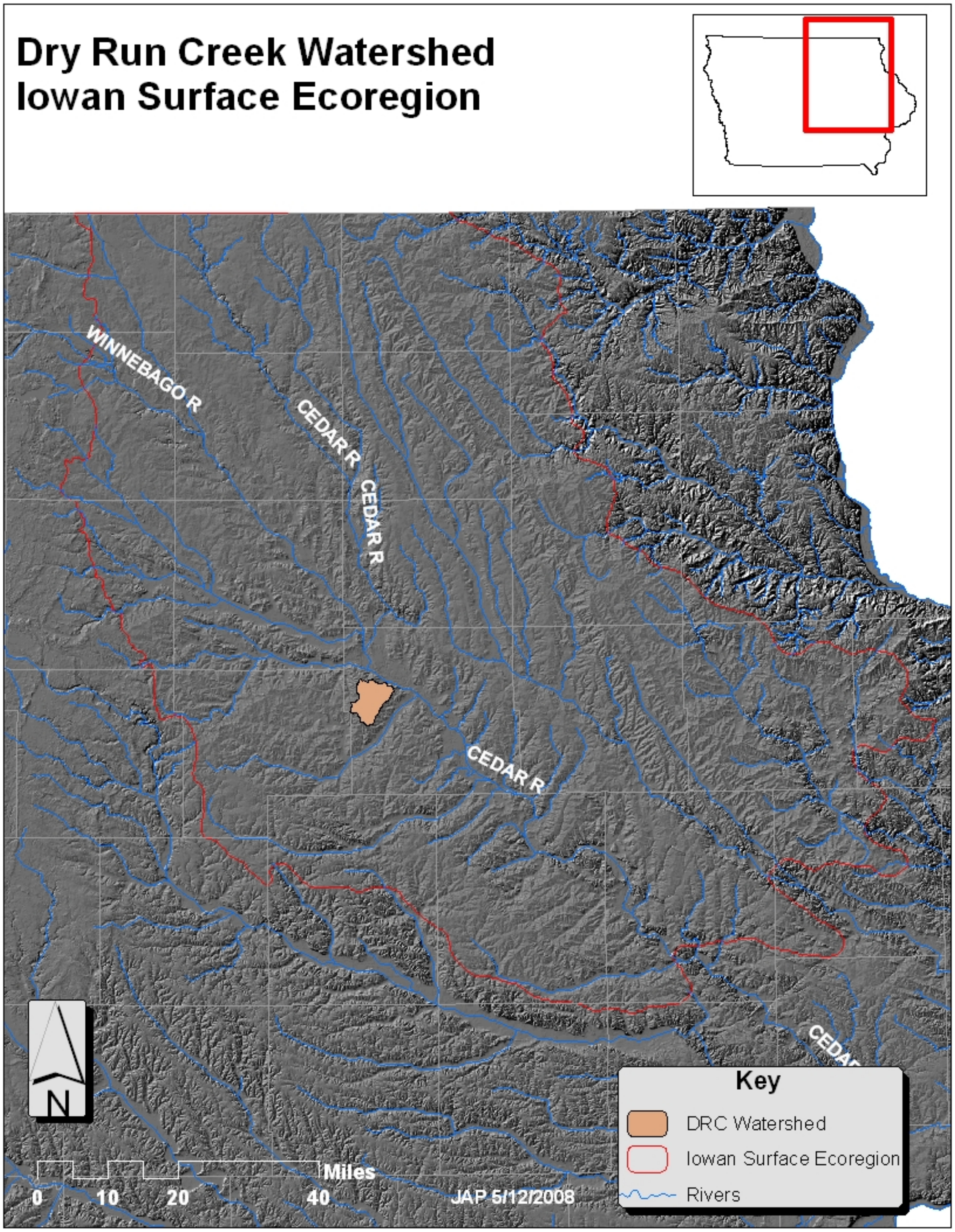

Figure 1 The location of the Dry Run Creek Watershed relative to the Iowan Surface Ecoregion

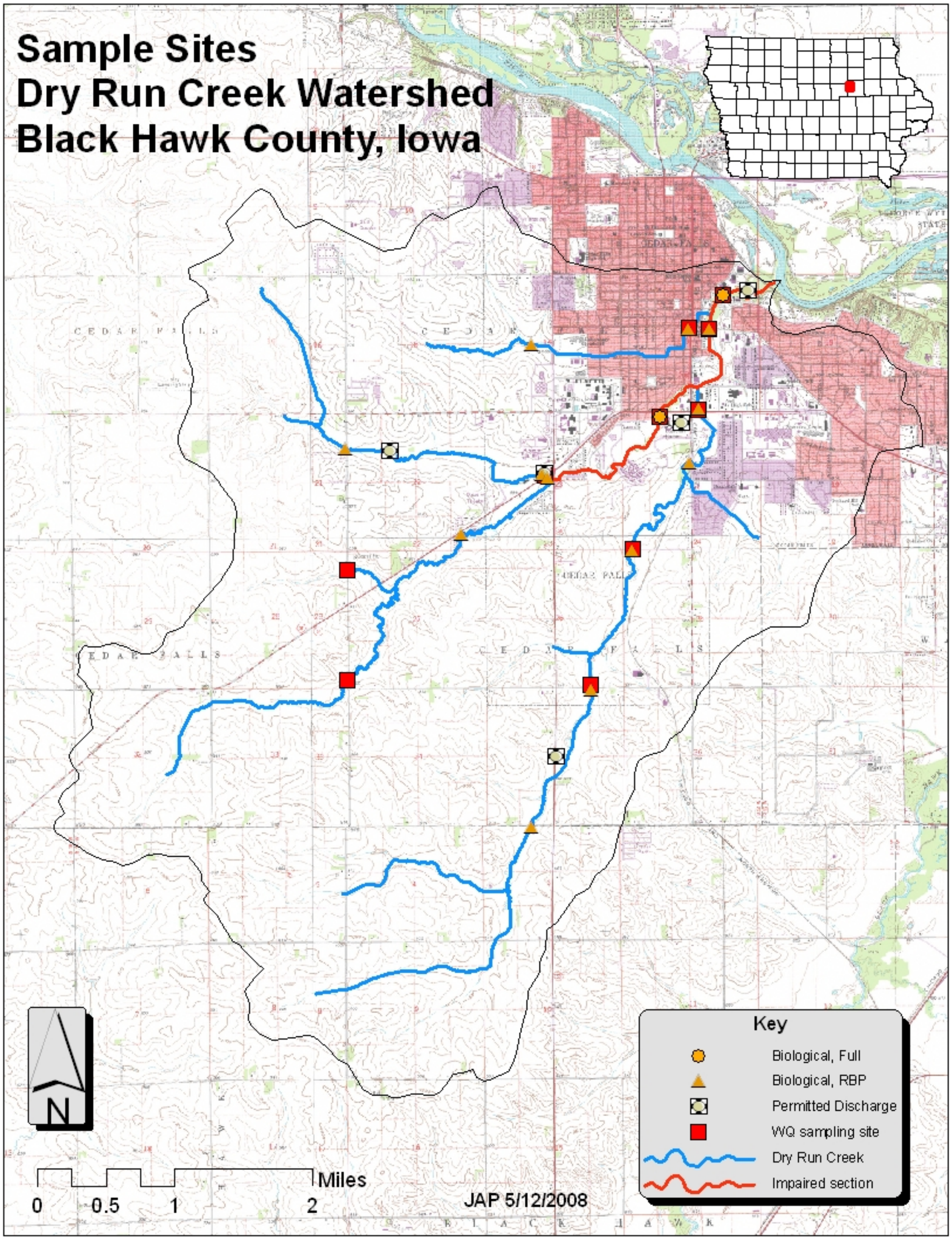

Figure 2 Sampling locations and permitted point source dischargers in the Dry Run Creek Watershed

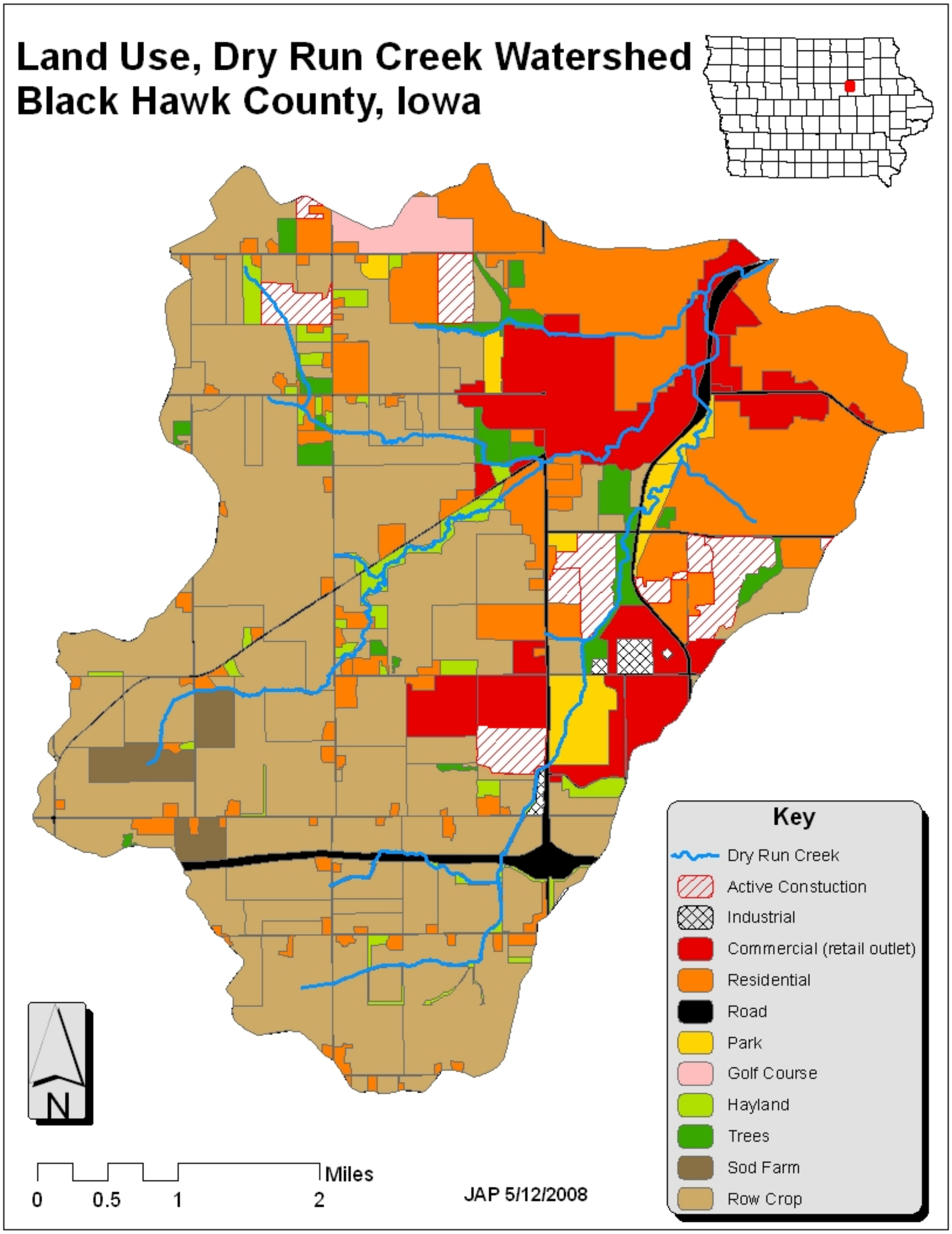

Figure 3 Land uses in the Dry Run Creek watershed based on 2006 aerial photography

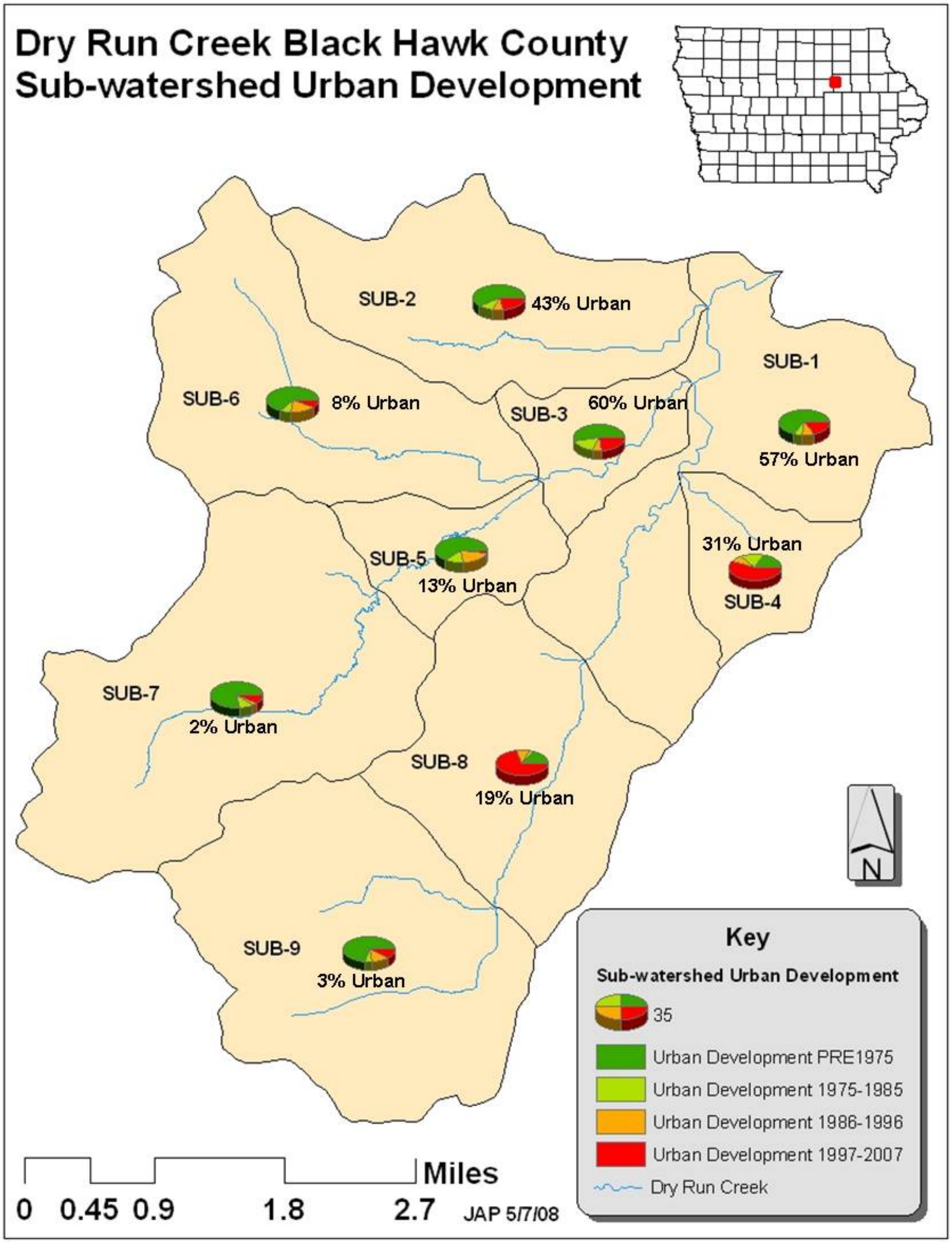

Figure 4 Dry Run Creek percentage of total urban development in 10 year increments back to 1975

The DRC watershed includes seven permitted point sources:

- One semi-public waste water treatment plant
  - Cedar Falls Mobile Home Village
- Four industrial sources
  - Cedar Falls Utilities
  - University of Northern Iowa
  - Quad State Gauging & Measurement
  - Nazareth Lutheran Church
- Two MS4 permits
  - The City of Cedar Falls
  - The University of Northern Iowa

Facility statistics including treatment type and effluent limits for Cedar Falls Mobile Village and the NPDES permitted industrial sources are listed in **Tables 1 and2.**

Table 1 WWTP in the Dry Run Creek Watershed

Facility	Cedar Falls Mobile Home Village (pond 1)	Cedar Falls Mobile Home Village (pond 2)
IA NPDES #	0709600	0709600
EPA #	IA0064033	IA0064033
Treatment type	1-cell lagoon[1]	2-cell lagoon[1]
CBOD5 (mg/l)[2]	25 (30-d)	25 (30-d)
TSS (mg/l)[2]	80 (30-d)	80 (30-d)
pH[2]	6.0 to 9.0	6.0 to 9.0
AWW (mgd)[3]	0.032	0.0135
Population Equiv.	240	114

1. These are controlled discharge treatment facilities that provide 180 days of wastewater storage.
2. These are the NPDES permit limits for this facility.
3. The AWW is 180-day average wet weather flow.

Table 2 Permitted industrial point source dischargers in the Dry Run Creek Watershed

Facility	Cedar Falls Utilities	Nazareth Lutheran Church	Quad State Gauging & Measurement	University of Northern Iowa
IA NPDES #	0709102	0709801	0709108	0709501
EPA #	IA0002534	IA0080047	IA0074071	IA0063941
Type of discharge	Cooling water blowdown	Non-contact cooling water	Non-contact cooling water	Boiler blowdown & non-contact cooling water
Flow Max daily (mgd)[1]	10.4			
TSS (mg/l)[1]	30 (30-d)			30 (30-d)
pH[1]	6.0 to 9.0	6.0 to 9.0	6.0 to 9.0	6.0 to 9.0
Chlorine total (mg/l)[1]	0.017 (30-d)	1.07 (30-d)		0.053 (30-d)
Temp ºF (Max)[1]		90.9		
Chromium (mg/l)[1]	0.2 (30-d)			0.2 (30-d)
Copper (mg/l)[1]	0.037 (30-d)			
Iron (mg/l)[1]	0.11 (30-d)			
Oil & Grease (mg/l)[1]	15 (30-d)			7.4 (30-d)
Zinc (mg/l)	1 (30-d)			1 (30-d)

1. These are the NPDES permit limits for the facility

2.2 Stream Flow and Water Quality

It is important to examine flow data at several scales to form a complete picture of stream flow within the DRC watershed. Yearly and seasonal trends were determined using the USGS Cedar River gauge at Cedar Falls; located near the confluence of DRC with the Cedar River. Stream discharge data from this gauge (**Figure 5**) illustrates a seasonal pattern for stage height within the Cedar River from January 2003 to December 2007. Similar to many watersheds in Iowa, peak annual flow typically occurs in the spring and summer while lower flows typically occur in the fall and winter. An exception to this trend occurred in 2007 when an abnormally wet late summer, fall and early winter produced flooding. In general this pattern represents a seasonal pattern of spring snow melt and increased precipitation during the spring and summer seasons.

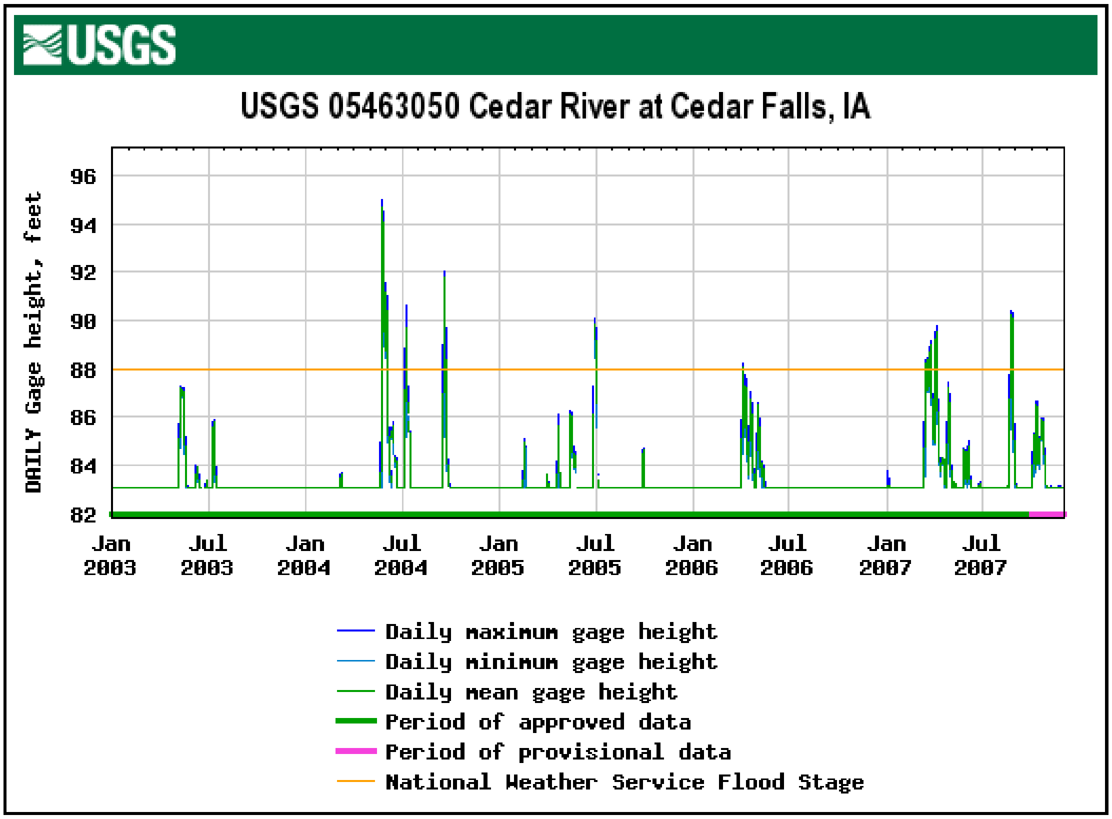

Figure 5 Historic stage height of the Cedar River at Cedar Falls depicting a general seasonal trend of wet springs and summers and dry autumns and winters.

The months of September and October 2007 were marked by several large rainfall events as evidenced by changes in flow (**Figure 6**) at the upstream end of the impaired segment of DRC (**Figure 2**) depicting a very flashy system that peaks and falls to base flow rapidly. The return to steady base flow of approximately 20 cfs indicates a sustained input from the coolant water discharges and ground water flow. During the time period when soil was saturated, even small rain events led to a quick response by the stream, as seen in the comparison of stream discharge to precipitation (**Figure 7**). A discussion of the impacts of urbanization on the hydrology of this stream network is located in the section on increased storm water inputs.

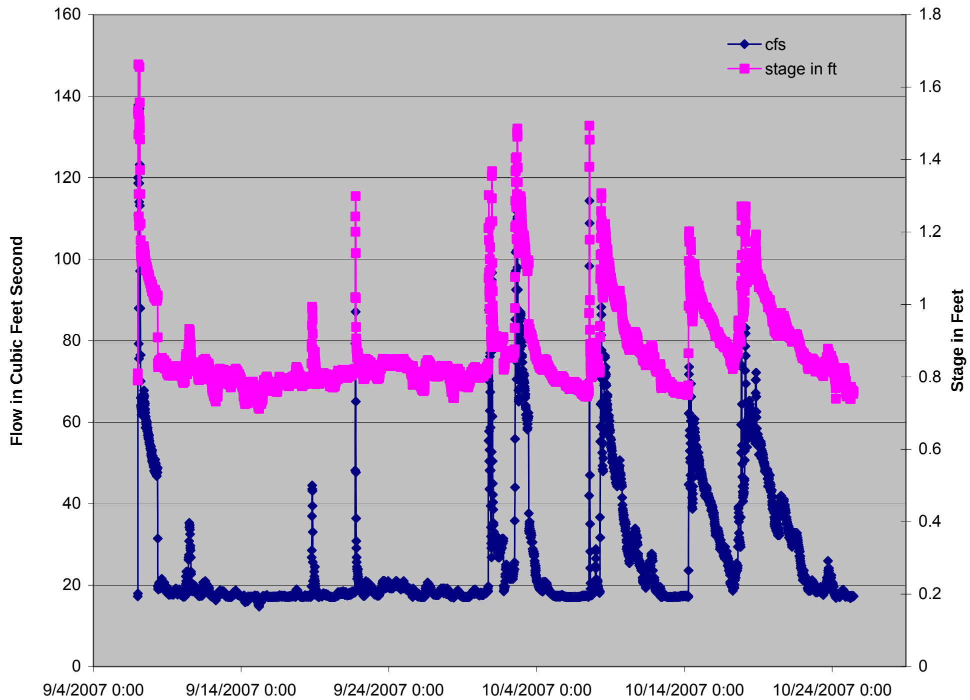

Figure 6 Relationship between flow and stage over time

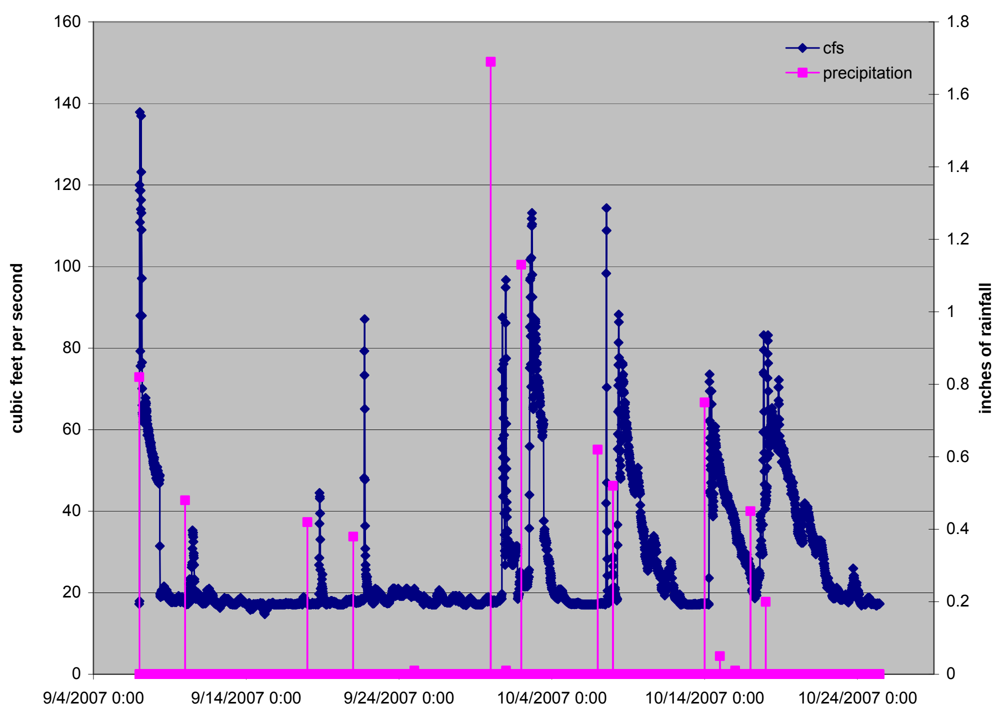

Figure 7 Response of stream stage to rain events

Water quality characteristics measured at DRC sampling sites located in the middle to lower sections of the watershed (**Figure 2**) are generally indicative of highly urbanized land uses (**Appendix 2; Table 2-1 to 2-3**). Elevated concentrations of chloride were detected at several monitoring sites located in this region of the watershed. High chloride concentrations are commonly found in urbanized stream systems. Further evidence of urban influence on water quality was observed during event sampling at two locations in the urbanized section of the watershed. In 18 storm event samples there were a total of 13 pesticides, three combustion chemicals, seven metals and two plastic degradation products detected (**Appendix 2; Table 2-11**). The urbanized portion of DRC's surface watershed is the likely source of this combination of chemicals.

Water samples from sites located in the rural areas of the watershed reveal concentrations of nutrients and suspended sediments representative of an agricultural landscape. The levels of these water quality parameters are at or slightly above those from least disturbed 47c ecoregion reference stream sites.

2.3 Biological Impairment

The SI watershed includes the entire DRC HUC 12 Watershed (HUC ID 070802050401) which contributes to the 2.8 mile impaired segment of DRC (Segment No. IA 02-CED-0390) (**Figure 2**). The impairment on DRC was originally attributed to data from a 1992 IDNR Stream Use Assessment (SUA) and was first reported in the 1994 Section 305(b) report. The 1992 SUA data and the occurrence of a fish kill in 1996 were combined to continue the assessment of DRC as "partially supporting" aquatic life uses in the 1998 report. This assessment was not carried forward to the 2000 report. For the 2002 report, DRC was assessed as "partially supporting" aquatic life uses on the basis of biological sampling conducted in 1999 for the DNR/UHL stream biocriteria project. The designated use segment of DRC was placed on Iowa's 2002 303d list of impaired waters and identified as a biological impairment due to unknown causes. Additional details about the assessments are provided below.

In June of 1992 fish sampling and visual habitat assessments were conducted on DRC as part of an IDNR SUA. The following was documented during the SUA: (DRC had) "*Relatively little diversity of substrate and only fair development of pool/ riffle sequences*", "*Fair diversity of fish species, but generally low abundances observed. Urban land use is probably a major contributor to degradation of stream*". As a result of this sampling the Section 305(b) water quality assessment for Class B (aquatic life) designated uses was assessed as "partially supporting." DRC was not biologically assessed again until 1999; however on July 25, 1996 a fish kill was reported which affected 0.3 miles of stream and killed over 60 fish. No data which could identify the cause of the kill was available.

The 1999 biological sampling in DRC was conducted as part of the IDNR/UHL Stream Biocriteria Project. Benthic macroinvertebrate and fish sampling results from the 1999 sampling in the DRC watershed are summarized in Appendix 2 (**Tables 2-19 & 2-20**). Follow-up sampling was conducted in 2005 at the original 1999 site (DRC 1) and one additional site (DRC 4) to further investigate the aquatic life use impairment. The biological data collected at the sampling sites included fish species richness, abundance and health that were used to develop a Fish Index of Biotic Integrity (FIBI) and benthic macroinvertebrate species richness and abundance data that were used to develop a Benthic Macroinvertebrate Index of Biotic Integrity (BMIBI). The 2005 FIBI scores from DRC watershed sites 1 & 4 (**Fig. 8**) was significantly lower than the FIBI reference biological impairment criterion (BIC) used to determine aquatic life use support status (**Table 3**). Benthic macroinvertebrate sampling at the same sites also uncovered a community with BMIBI scores well below the ecoregion BMIBI BIC. Standard biological data assessment procedures (IDNR 2004) were applied to sampling results from 2005. Based on this analysis, the Section 305(b) water quality assessments for 2006 biennial reporting cycle reported the status of Class B (aquatic life) designated uses as “partially supporting” and DRC remained on the Section 303(d) list of impaired waters. Also during 2005, biological sampling was conducted using the IDNR Rapid Bioassessment Protocol (RBP) at 12 sites located in the DRC watershed (**Fig 8**). The RBP data set was obtained to provide a broader characterization of stream biological conditions across the watershed.

The BMIBI and FIBI scores rank the stream biological condition on a rising scale from 0 (minimum) to 100 (maximum) (**Appendix 1; Tables 1-2 & 1-3**). The BMIBI and FIBI scores from sampling locations in the DRC watershed (**Table 3**) are mostly in the range described as *“Fair”* stream biological condition. The shaded columns in **Table 3** list the BIC that are determined from ecoregion reference stream sites (IDNR 2005 b). The BMIBI and FIBI scores from all sampling years and locations in the DRC watershed are below the reference BICs. These results provide reasonably strong evidence that the biological impairment is consistent across space and time. At site DRC1, both the BMIBI and FIBI scores declined approximately 12% from 1999 to 2005. However, the level of change is within the interannual range of IBI variation measured among least disturbed reference sites; therefore, a declining trend can not be inferred from these limited data.

Table 3 Index of Biotic Integrity scores for benthic macroinvertebrates (BMIBI) and fish (FIBI) from the DRC watershed

Site	Year	BMIBI	BMIBI Biological Impairment Criterion (BIC)	FIBI	FIBI Biological Impairment Criterion (BIC)
DRC 1	1999	48	70	50	44
DRC 1	2005	42	70	44	44
DRC 4	2005	38	70	38	65

The IBI results are the primary evidence of aquatic life use impairment in the DRC watershed. In terms of the diagnosis of stream problems, however, the IBI’s are not as useful as the individual metrics that comprise them. Each metric contains unique information about the stream biological community and reflects somewhat distinctive responses to environmental perturbations. Therefore, the IBI metrics from DRC watershed sites (**Appendix 2; Tables 2-19 & 2-20**) have been analyzed in an effort to extract more specific information about the biological impairment and what the metric responses suggest about the types and magnitude of environmental stressors that are affecting the aquatic community. The full biological sampling FIBI and BMIBI metric scores were analyzed two ways: 1) by comparing the metric scores to regional reference site metric scores and 2) independently analyzing by site, the metric score contribution (or lack of) to the overall index score.

The observed differences in FIBI data metric levels between sites and sampling years make it difficult to single out the most degraded aspects of the Dry Run Creek fish community. A comparison of 1999 and 2005 FIBI metric data from DRC1 with reference stream site metric levels shows inconsistencies in the metrics of greatest departure from reference levels (**Appendix 2; Table 2-21)**. These inconsistencies suggest that stream habitat conditions that fish populations respond to have been dynamic in the recent past. A comparson of 2005 FIBI metric levels at DRC1 and DRC4 also suggests there are important spatial differences in fish assemblages within the watershed.

In 2005, six FIBI metrics were rated as either marginal or not comparable to reference site metric levels at both DRC1 and DRC4: 1) number of native species; 2) number of sensitive species; 3) number of benthic invertivore species; 4) percent abundance three most abundant species; 5) percent abundance simple lithophilous spawning fish; 6) fish tolerance index. Only the percent abundance three most abundant fish species metric was evaluated as not consistent with reference levels at both sites.

The BMIBI metrics were generally more consistent than FIBI metrics across sample years and sites (**Appendix 2; Table 2-22)**. Two metrics were evaluated as not consistent with reference conditions in all three samples: multi-habitat (MH) number of sensitive taxa and standard habitat (SH) percent abundance scraper organisms. In 2005, three additional metrics were considered not consistent with reference conditions at both DRC1 and DRC4: MH number of EPT taxa; MH number of EPT taxa; SH percent abundance of Ephemeroptera (mayflies).

Each IBI metric relates to a different aspect of the aquatic community and provides useful insight to potential impairment causes. Descriptions of the FIBI and BMIBI metrics and their ecological relevance can be found in Section Three of the IDNR report, "Biological Assessment of Iowa's Wadeable Streams" (http://wqm.igsb.uiowa.edu/wqa/streambio/index.html) (Wilton 2004).

The Rapid Bioassessment Protocol (RBP) sampling data were analyzed similarly to full biological sample data with respect to metric analysis and comparison with reference conditions. Three benthic macroinvertebrate data metrics and four fish assemblage metrics were calculated from the RBP sampling data set (**Appendix 2; Tables 2-23 & 2-24**). The metric data scoring criteria were developed and calibrated using the reference site data for the Iowan Surface (47c) ecoregion. Metric scoring criteria were developed using the data trisection procedure and 5, 3, 1 numeric rating system (Karr et al. 1986). After rating each individual metric, averages of the benthic macroinvertebrate metric ratings, fish metric ratings, and combined aquatic community metric ratings were obtained. RBP metric ratings were also calculated for the full biological sampling sites, DRC1 and DRC4, which allowed for a comparison of RBP and full biocriteria assessment approaches.

The overall mean of site fish metric ratings was 2.63 (not consistent with reference condition) compared with 3.49 (marginally consistent) for the benthic macroinvertebrate overall site mean (**Appendix 2; Tables 2-23 & 2-24**). Eight of fifteen sites (53%) analyzed had an average RBP fish metric rating evaluated as not consistent with reference expectations, compared with four sites (27%) evaluated not consistent for benthic macroinvertebrates. From these results it is tempting to conclude the fish community is more seriously impaired than the benthic macroinvertebrate community. However, it must be remembered the benthic macroinvertebrate data represent family-level taxonomic identifications compared with species level for fish. Very possibly, some ability to discriminate RBP sites from reference site metric levels is obscured by conducting the benthic macroinvertebrate analysis at the more generalized family taxonomic level.

With respect to the combined averages of benthic macroinvertebrate and fish metric ratings, 40% (6/15) of the RBP sites had an average rating considered not consistent with reference conditions. Within the watershed, the strongest evidence of biological impairment was found at the two full biological sampling sites located on the originally impaired segment, as well as the four RBP sites on the southeast branch of DRC (**Appendix 2; Tables 2-23 & 2-24**). Only RBP site #11 on the northeast branch had benthic macroinvertebrate and fish metric ratings that are considered consistent with reference levels.

In regards to specific metrics, the overall site means for three of the four RBP fish metrics were evaluated as not consistent with reference conditions (**Appendix 2; Table 2-23**). The fish tolerance index metric had the overall lowest ranking (2.07), with 8 of 15 (53%) of sites evaluated not consistent with reference levels. Among RBP benthic macroinvertebrate metrics, the number of EPT taxa metric had the lowest overall ranking (3.13), with 4 of 15 sites (27%) of the sites evaluated as not consistent (**Appendix 2; Table 2-24**).

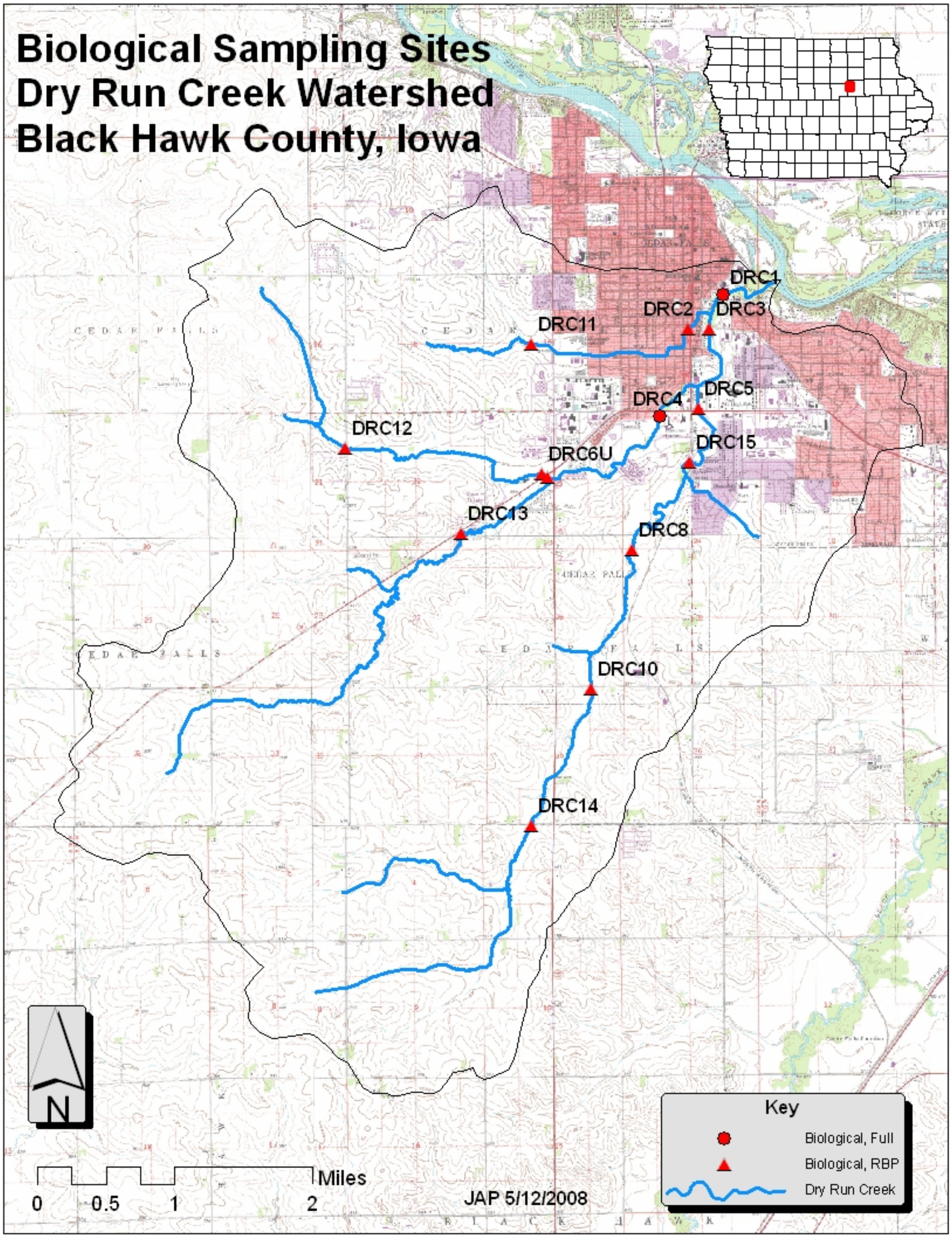

Figure 8 Dry Run Creek biological sampling locations

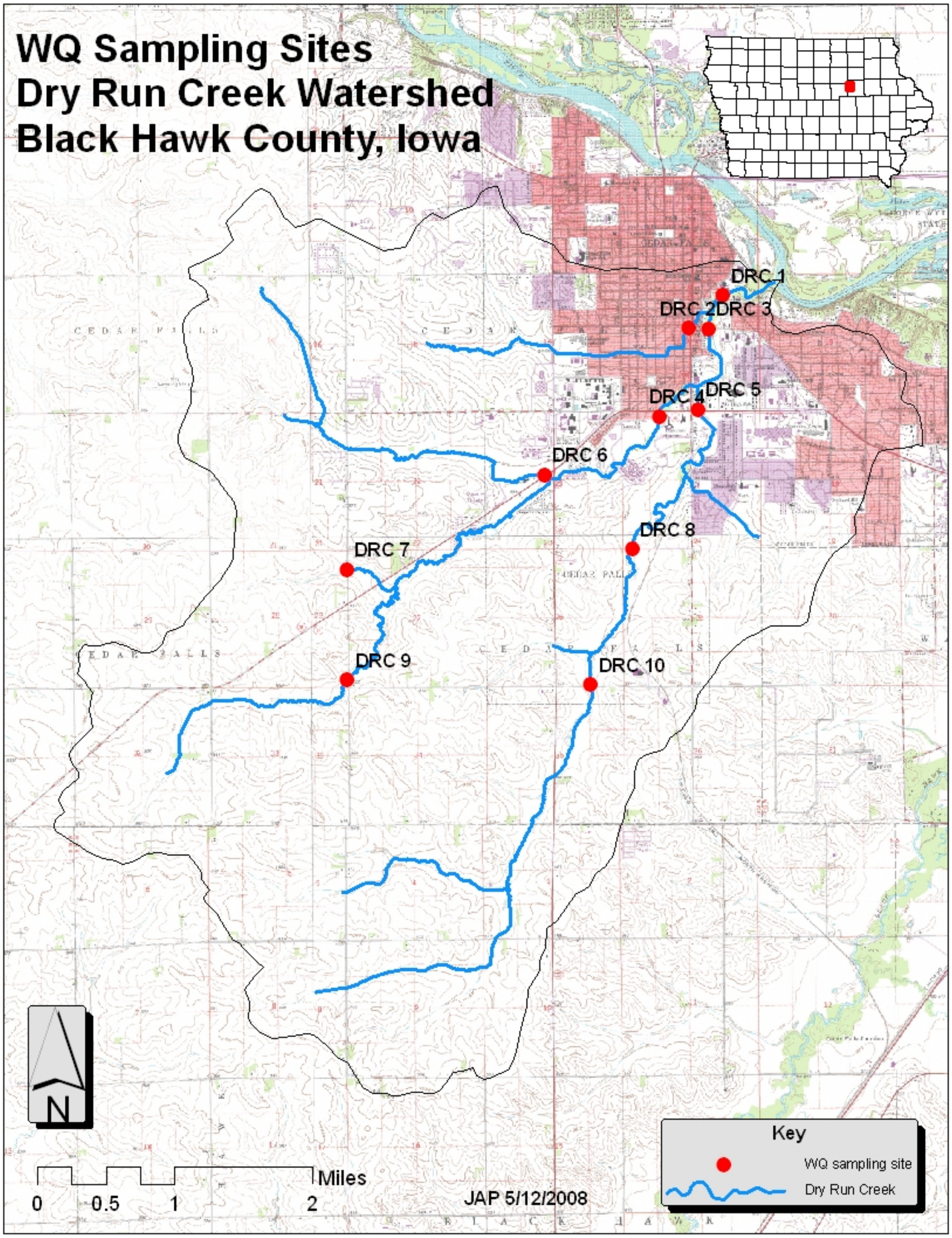

Figure 9 Dry Run Creek water quality sampling locations

3. Stressor Identification Process

Iowa's SI procedures (IDNR 2005) are adapted from technical guidance documents developed by the U.S. EPA (2000, 2005). The EPA also supports an on-line resource named "Causal Analysis/Diagnosis Decision Information System" (CADDIS) (http://cfpub.epa.gov/caddis/) where SI-related information and tools are available.
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3.1 Candidate Causes and Theoretical Associations

Candidate causes for SI analysis are chosen from the IDNR generalized list of aquatic life use impairment causes (IDNR 2005). The candidate cause list includes most of the pollutant and non-pollutant based causal agents that are known to adversely impact aquatic life in Iowa's rivers and streams. It is important to note that candidate causes are identified at varying scales and degrees of separation from the proximate stressor that actually elicits an adverse in-stream biological response. Conceptual models (**Appendix 3**) are used to illustrate the mechanisms and pathways that link activities or sources in a watershed with proximate stressors. From this perspective, an impairment cause can be viewed more broadly as encompassing the stressor itself, the activities or sources that produce the stressor, and the mechanism(s) and pathway(s) by which the stressor is manifested in a stream. Conceptual models are also a useful means of organizing the evidence review process, which is discussed later (section 3.4).

A ranking process is used to reduce the master list of candidate causes to a manageable size. After a cursory review of sampling data, watershed land use and other pertinent information, each candidate cause is assigned a rating (high, medium, low) based upon the relative probability any given cause, by itself, could be responsible for the observed impairment. The final ratings are obtained by consensus opinion among SI team members (usually 5 or 6 individuals). Candidate causes ranked as medium or high probability are selected for the analysis of causal association. While not completely eliminated, candidate causes ranked as low probability are not advanced for further consideration. Low probability candidate causes can be reconsidered should the evidence analysis process fail to identify likely causes from the primary list.

Table 4 Dry Run Creek Watershed aquatic life use impairment candidate causes and probability rankings: (1) high; (2) medium; (3) low.

- Toxins (sediment and water)
  - Metals
    - Arsenic (2.5)
    - Cadmium (2.5)
    - Chromium (2.5)
    - Copper (2.5)
    - Lead (2.5)
    - Mercury (2.5)
    - Selenium (2.5)
    - Zinc (2.5)
    - Other
  - Non-Metals
    - Chlorine (1)
    - Cyanide (3)
    - Oil / grease (2)
    - PAHs (2)
    - Pharmaceuticals (3)
    - SOCs (3)
    - Unionized ammonia (2)
    - Other
  - Pesticides
    - Fungicides (3)
    - Herbicides (2)
    - Insecticides (1.5)
    - Other
- Water quality characteristics
  - Chlorophyll a (2)
  - Dissolved oxygen (1)
  - Nutrients
    - Nitrogen (2)
    - Phosphorus (2)
  - pH (3)
  - Salinity / TDS (2)
  - Turbidity / TSS (1.5)
  - Water temperature (2)
- Habitat Alterations
  - Bank erosion (1.5)
  - Channel incision / loss of floodplain connectivity (2)
  - Channel Straightening (1)
  - Dewatering (3)
  - Excessive algae/macrophyte growth (2.5)
  - Flow impoundment (3)
  - Lack of woody debris / channel roughness and structure (2)
  - Physical barriers (1.5)
  - Riparian vegetation loss (1)
  - Sedimentation (2)
- Hydrologic Alterations
  - Flow diversion (3)
  - Flow regulation (dams) (2)
  - Pumping (withdrawals) (3)
  - Subsurface tile drainage (2)
  - Urban stormwater outfalls (1)
  - Wetland loss (3)
- Exotic/Introduced Species and Other Biotic Factors
  - Competition (3)
  - Disease (3)
  - Endrocrine disruption (3)
  - Harvest (3)
  - Refugia depletion/isolation (2)
  - Predation (3)

3.2 Analysis of Associations

The analysis of associations is a multi-step process comprised of thirteen types of evidence consideration (**Table 5**). The analysis begins with a consideration of the temporality and spatial co-occurrence of the stressor and effect. These two considerations examine the evidence indicating whether a given stressor and detrimental stream biological response occur at the same time in the same place.

Table 5 Evidence considerations that comprise the analysis of stressor-effect associations (U.S. EPA, May 2005: Handbook for characterizing causes. Eighth Edition).

Evidence Consideration	Description
Temporality	The effect occurs when the candidate cause occurs and the effect is absent when the candidate cause is absent.
Spatial Co-occurrence	The effect occurs where the candidate cause occurs, and the effect is absent where the candidate cause is absent.
Biological gradient	Effects decline as exposure declines over space and time.
Complete causal pathway	A causal pathway is present representing the sequence of events that begins with the release or production of a stressor from a source and ends with an adverse biological response.
Mechanistically plausible causal pathway	Evidence is available from the site or elsewhere that the causal mechanism is plausible.
Plausible effect given stressor-response relationship	Site exposures are at levels that cause effects in the laboratory, in the field, or in ecological process models.
Consistency of association	Repeated observation of the effect and candidate cause in different places or times especially if the methods of measurements are diverse.
Analogy	Similar candidate causes have been shown to cause similar effects.
Specificity of cause	Specific effect occurs with only a few causes
Manipulation of exposure	Toxicity tests, controlled studies, or field experiments (site specific or elsewhere) demonstrate that the candidate cause can induce the observed effect.
Predictive performance	Candidate cause results in other predicted conditions not encompassed by the initially observed effects.
Evidence Consistency	The hypothesized relationship between cause and effect is consistent across all available evidence.
Evidence Coherence	There are no inconsistencies in evidence or some inconsistencies that can be explained by a possible mechanism.

Upon review, the DRC data set was determined inadequate for examining temporal relationships of stressors and effects. A major hindrance to considering this line of evidence is the lack of coordinated monitoring for stressors and effects over time. There was not a clear sequence of evidence demonstrating that the stressor(s) were introduced into the stream prior to the onset of degraded biological conditions.

3.3 Spatial Co-occurrence and Stressor-Response Relationships

The evidence considerations for Spatial Co-occurrence and Plausible Effect Given Stressor-Response Relationship involved comparison of sampling data from the DRC watershed with data collected for the IDNR stream biological assessment program initiated in 1994. DRC sampling data and benchmarks were reviewed for spatial co-occurrence and stressor-response evidence considerations. For spatial co-occurrence, DRC stressor indicator data were compared with interquartile data ranges (IQR: 25th to 75th percentile) for stream reference sites within the Iowan Surface Ecoregion (47c). In cases where reference data were not available, DRC sampling data were compared with data from the statewide probabilistic (random) survey of perennial streams, a sampling project adapted from the U.S. EPA's Regional Environmental Monitoring and Assessment Program (REMAP). Other benchmarks such as maximum or minimum ecoregion reference values, state water quality standards, or mean values from statewide random survey sites were applied in lieu of the reference IQR. A stressor was deemed present at a site when the appropriate indicator value exceeded the benchmark value.

The next step was to determine whether the stressor exists at a level that is expected to elicit adverse effects to the aquatic community. This analysis of stressor response was done by examining stressor-response relationship curves developed from Iowa's statewide stream bioassessment database. The database contains sites with BMIBI and/or FIBI scores as well as water quality and stream habitat measurements. A description of conditional probability, one technique used to evaluate stressor-response relationships may be found in **Appendix 1, Section D**. In lieu of data sufficient to develop relationship curves from ecoregion or statewide data, stressor levels were determined using water quality standards for acute and chronic toxicity, EPA or other government agency biotic threshold values, or stressor relationships obtained from scientific literature.

3.4 Complete Causal Pathway

Following the evaluation of spatial co-occurrence and stressor-response relationships, the available stream and watershed information were reviewed to determine the plausibility of hypothesized causal pathways linking sources to biological impairment. Similar to the approach used for considering co-occurrence and stressor-response relationships, data from DRC were compared to interquartile data ranges from reference sites within the 47c ecoregion or data ranges for statewide random survey sites. The indicator data and other relevant information were evaluated qualitatively and/or quantitatively to evaluate the evidence supporting each hypothesized causal pathway. The results of this evaluation process are shown in the causal pathway conceptual model diagrams in **Appendix 3**.

3.5 Strength of Evidence

The U.S. EPA (2005) handbook for characterizing causes served as the primary guidance document for evidence analysis and ranking. The main types of evidence consideration utilized in this SI are: *Spatial Co-occurrence; Plausible Effect Given Stressor-Response Relationship; Complete Causal Pathway and Consistency of Association*. All of these evidence considerations incorporated data from DRC along with ecoregion-specific or statewide sampling data. The DRC sampling data were not sufficient to perform the *Temporality* and *Biological Gradient* evidence considerations. The review team was unable to identify any analogous stressor-response scenarios; therefore, the *Analogy* line of evidence contributed nothing to the DRC SI. Other lines of evidence were selectively applied depending on the stressor and data/evidence. The results of the strength of evidence analysis are summarized in **Table 6**.

Table 6 Summary of strength of evidence analysis results for proximate stressors

Proximate Stressor	Evidence Consideration											
	Temporality	Co-occurrence	Biological gradient	Complete causal pathway	Mechanistically plausible causal pathway	Plausible effect given stressor-response relationship	Consistency of association	Analogy	Specificity of cause	Manipulation of exposure	Predictive performance	Evidence Consistency	Evidence Coherence
↑ Peak Discharge Frequency & Magnitude	0	0	0	+++	+++	+	+	na	0	+++	na	+	+
↑ Low Flow Frequency & Magnitude	0	0	0	+	+	0	+	na	0	0	na	+	+
Δ in daily or seasonal flow patterns	0	0	0	+++	+++	0	-	na	0	0	na	+	+
↑ TSS / Turbidity	0	0	0	+++	+++	+	+	na	0	0	na	+	+
↑ Sedimentation	0	0	0	+++	+++	+	+	na	0	+++	na	+	+
↓ Primary producer composition	0	0	0	+++	+++	+	+	na	0	0	na	+	+
↓ Allochthonous food resources	0	0	0	+	++	0	-	na	0	0	na	+	+
↓ Dissolved Oxygen	0	0	0	+++	+++	+	+	na	0	+++	na	+	+
Δ Seasonal temperature fluctuation	0	0	0	+++	+++	+	+	na	0	0	na	+	+
↑ Temperature	0	0	0	+	+	0	+	na	0	0	na	+	+
↓ Diurnal temperature fluctuations	0	0	0	+++	+++	+	-	na	0	0	na	+	+
↓ Macro-habitat Complexity	0	0	0	+++	+++	+	+	na	0	0	na	+	+
↓ Instream Cover / Epifaunal Micro-habitat	0	0	0	+++	+++	+	+	na	0	+++	na	+	+
↑ Insecticides	0	0	0	+++	+++	+	+	na	0	+++	na	+	+
↑ Herbicides	0	0	0	+++	++	+	+	na	0	+++	na	+	+
↑ Un-ionized Ammonia	0	0	0	+	++	0	+	na	0	+++	na	+	+
↑ Chlorine	0	0	0	+	++	+	+	na	0	+++	na	+	+
↑ Oil / grease	0	0	0	+	++	0	+	na	o	+++	na	+	+
↑ PAH's	0	0	0	+	++	0	+	na	0	+++	na	+	+
↑ Chloride/TDS	0	0	0	+++	+++	+	+	na	0	0	na	+	+
Physical barriers	0	0	0	+++	++	0	+	na	0	0	na	+	+

4. Primary Causes

The proximate stressors identified during the SI process (not ranked by order of importance) are:

- Increased urban storm water inputs
- Increased suspended and bedded sediment
- Decreased macro-habitat complexity and decreased in-stream cover

Problems associated with habitat in the DRC watershed are directly tied to storm water and in-stream sediment processing (storage and transport) characteristics. Therefore the discussion of habitat alterations and the associated potential impacts on stream biota are embedded in the two sections for storm water and sediment. The supporting evidence for each primary cause (i.e., proximate stressor and associated causal pathways) is described below.

4.1 Increased Urban Storm Water Inputs

Although the exact mechanism may be hard to identify, it is clear that storm water contribution from urban areas can greatly depress in-stream biological conditions. Multiple studies have shown a linkage between increased urbanization and alterations in community composition, reduced taxa richness and diversity, and an increase in pollution tolerant taxa in macroinvertebrate communities (Stepenuck *et.al*. 2002; Booth and Jackson, 1997; Jones and Clark, 1987). Studies conducted on 43 southern Wisconsin streams showed that levels of imperviousness between 8 - 12 percent represented a threshold where minor increases in urbanization were associated with sharp declines in macroinvertebrate communities (Stepenuck *et.al*. 2002). Additional studies in the same streams showed that number of fish species per site and fish IBI scores were consistently low in watersheds with greater than 10 percent imperviousness (Wang *et. al.* 2000).

Overall, 9 percent of the DRC watershed surface is covered by impervious surfaces. Urbanization in the central portions of the watershed has increased significantly over the last decade (**Figure 4**). Data on urban development in the DRC watershed, determined on a yearly basis utilizing GIS information from the Black Hawk County assessor's office, showed that certain areas of the watershed have experienced a 200 percent increase in urban land use over the last decade. Sub-watersheds 4 and 8 along the southeastern branch of DRC had the highest percent increase in the watershed over the past decade.

The increased volumes and delivery rates of storm water flow from urbanized sections of the DRC watershed have significant impacts, direct and indirect, on stream biota. Increases in stream flow velocities directly impact biota through increased hydraulic scour of benthic surfaces. Organisms exposed to these shear forces may be dislodged and transported downstream, experience stresses that reduce reproduction and feeding efficiency, or may suffer from direct mortality. Increased in-stream velocities also have indirect impacts on stream biota. Large increases in stream velocity can scour periphyton, which mainly grows on the upper surfaces of benthic substrate, reducing food available for organisms in the scraper feeding guild. Scraper organism proportional abundance at the DRC 1 and DRC 4 full biological sampling sires was lower than the 25th percentile of ecoregion reference sites (**Appendix 2; Table 2-19**). Increases in magnitude and frequency of peak velocities can destabilize the stream bed resulting in frequent mobilization of benthic surfaces. This reduces colonization potential and in extreme cases may result in the direct burial of organisms.

Rapid increases in stream velocities can exert pressures on more than just the biota in the stream system. Increases in peak velocity will result in changes in channel geomorphology. Typical reactions include channel incision (bed degradation) followed by channel widening (streambank sloughing/erosion). These channel adjustments are a direct response to increased flow and are predictable and constant across landscapes (Lane, 1955; Schumm, 1999; Simon, 1989). Large scale changes in channel form impact micro and macro habitat stability and availability, placing stress on resident biota; this is corroborated by biological sampling results. For example, levels of benthic macroinvertebrate metrics at DRC 1 and DRC 4 that relate to macro- and micro- scale habitat complexity and stability (e.g., multi-habitat total taxa richness, multi-habitat EPT taxa richness) were reduced compared with expected levels from ecoregion reference sites. Fish species richness, another diagnostic indicator of overall habitat complexity, was lower at DRC 1 and DRC 4 in 2005 compared with reference expectations (**Appendix 2; Table 2-19 & 2-20**).

Channel and floodplain modification and changes in discharge caused by changes in watershed land use may alter physical features of the stream network. This includes, peak discharge, lateral and longitudinal connectivity, sediment transport characteristics, and the retention and accumulation of woody debris and organic materials. The quantification of peak discharge velocities during storm events in DRC could not be accurately calculated due to a lack of velocity measurements at high flow conditions. Field crews responding to storm event sampling indicated the time period between peak discharge conditions and baseflow was too short to take manual measurements in the stream. Field crew reported that “Just hours after major rain the flood peak has passed through the channel system and we can barely tell that the stream had ever even come up”. Changes in stream stage recorded (by ISCO 6712 auto sampler units outfitted with bubble lines) during rain fall events (**Figure 10**) uncover a flow regime characterized by rapid fluctuations in short periods of time. These extreme swings in flow are in direct response to the riparian and upland watershed land use conditions.

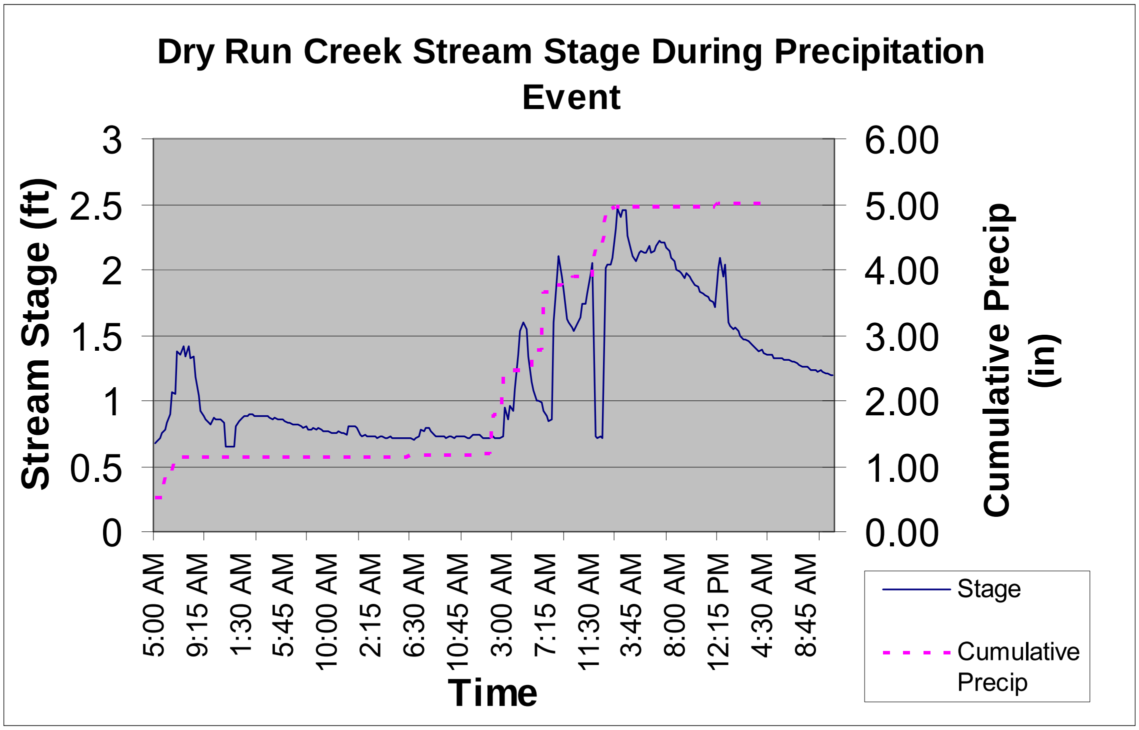

Figure 10 Stream stage at DRC 4 during a storm event

Habitat data collected at both full biological and RBP sites indicated that altered geomorphic conditions exist throughout the watershed. Width-to-depth ratios collected at sites DRC 1 and DRC 4 were 18.6 and 10.1 respectively. These width-to-depth ratios fall into the range that indicates channel incision/bed degradation. This is supported by observations noted by field staff during RBP biological sampling throughout the watershed. At eight of the 13 RBP sites, field staff indicated a lack of channel sinuosity and at 10 of 13 sites, deep channel incision was noted. These observations combined with known land use history of the watershed indicate that in addition to urban runoff, peak velocities in the stream are likely increased as a result of widespread channelization. Stream channelization removes stream meanders, increases stream gradient, shortens stream length, and decreases in-channel water and sediment storage capacity. The result of this activity is a channel that conveys water downstream in an extremely efficient manner, placing further hydrologic pressures on in-stream features downstream of the reach.

Comparisons between aerial photography from the late 1930's and 2006 show many sections of stream were channelized, removing outside bends, thus reducing channel length between the 1930's and present day (**Appendix 2; Figure 2-25**). Stream reaches in DRC were digitized from aerial photos from the 1930's and 2006. A comparison of past and present stream locations showed a 12 percent reduction in stream length over the last 70 years. Reduction in stream length is most pronounced on the southeast branch of DRC where a 16 percent reduction has occurred. It was not possible to develop a biological gradient related to channel condition due to the poor biological conditions throughout all sampling sites along the stream. However, some of the lowest biological rankings in the watershed were found along the southeast branch. The southeast branch contained sites with five of the six lowest fish RBP tolerance values, four of the six lowest macroinvertebrate tolerance values, the three lowest average fish RBP metric scores, and four of the five lowest benthinvertivore fish species metric scores (**Appendix 2; Tables 2-23 & 2-24**). While degraded biological scores persist throughout the watershed, overall the southeast branch exhibited the worst biological conditions (**Appendix 2; Figures 2-9 & 2-10**).

Impacts associated with storm water runoff are not limited to direct hydrologic effects. Increased storm water runoff is consistently associated with an increase in pollutant loads. Storm water pollutant loading is likely impacting the biological community in DRC. The degree to which the impairment can be attributed to storm water pollutant loading or the contribution of specific pollutants to the problem cannot be determined.

A total of 18 storm event samples were collected at DRC 1 and DRC 4 (**Figure 9**). Seven samples were screened for 174 different chemicals and metals. A total of 13 pesticides, four metals and two plastic degradates were identified in the water column (**Appendix 2; Tables 2-8 & 2-9**). All but one of the chemical and metal parameters present in the water column during storm events occurred below known threshold levels of chronic or acute toxicity. The insecticide Chlorpyrifos was detected at site DRC 1 on 8/5/2007 at a concentration of 0.05 µg/L. The EPA recommended threshold values for chronic and acute Chlorpyrifos toxicity are 0.041 µg/L and 0.083 µg/L respectively (U.S. EPA 2006). Chlorpyrifos was detected in only one sample during the three years of water quality monitoring on DRC and data from this investigation was insufficient to determine whether Chlorpyrifos is a significant contributor to the impairment on DRC. The detection limit for Chlorpyrifos at the University of Iowa Hygienic Laboratory is 0.05 µg/L. Therefore, it is possible that Chlorpyrifos occurs at levels significant to stream biota but is not detected by current analysis methodologies.

Chloride, an ion common to urbanized watersheds, can impact freshwater biota by altering the osmotic balance between an organism and the water in which it lives. Chloride loads commonly enter freshwater streams through industrial and municipal point sources and via non-point runoff from salted road and parking lot surfaces. Chloride concentrations in DRC tended to peak in the late winter and early spring and then level off through the rest of the year. This trend indicates that road salt application during the winter months is likely the primary source of chloride in the watershed. In December, 2005 and in March, 2008 samples were taken at the 10 water quality monitoring sites (**Figure 9**) during melt water runoff events in an attempt to capture the influx of chlorides from road salt. The five highest chloride values from the 2005 sampling (**Appendix 2, Table 2-14**) occurred along the south east branch at sites 1, 3, 5, 8, and10 (**Figure 9**). Data collected during bi-weekly sampling in March of 2006 also showed the highest chloride values in these sections of the stream network **(Appendix 2, Figure 2-15**). The melt water sampling in the spring of 2008 were separated by 11 days (3/2/2008 and 3/13/2008). The first event represented the first major thaw of the season. The second event occurred during a melt event accompanied by a rain event. Chloride concentrations were much higher in the first event than in the second (**Appendix 2, Tables 2-13-A & 2-13-B**).

As with previous data collection, in each event some of the highest concentrations of chloride were observed along the southeast branch of DRC. Sites 1, 3, and 5 had in-stream chloride concentrations of 430, 360, and 470 mg/L respectively. Melt water sampling was expanded to include major storm water outfalls during the 2008 sampling (**Appendix 2; Figure 2-15**). Outfalls were selected on each of the major tributaries and represented commercial, residential and industrial areas of town. During the initial snow melt event in 2008, outfalls 2, 4, and 7 had the highest concentration of chloride (800, 560, and 400 mg/L respectively). At 72 inches, outfall number 4 is the largest storm water outfall in the watershed (**Figure 11**) and during storm events has the potential to contribute a significant amount of flow to the stream. Discharge measured at site DRC 5 and at outfall 4 during the March 2nd event provides evidence to this assertion. The flow measured at outfall 4 was 6.85 cfs. Roughly a quarter mile downstream and 20 minutes later at DRC 5 flow was measured at 9.13 cfs. Given these values, it appears that outfall 4 was contributing roughly 75 percent of the stream flow at that location. This underscores the huge impact the storm water system in this watershed has on in-stream attributes (both chemically and physically).

Figure 11 Outfall # 4 during melt water event of March 2nd 2008

Sediment samples taken at DRC 1 and 4 uncovered six metals, three herbicides and three combustion chemicals (**Appendix 2; Table 2-10**). Individual sample results for sediment metal concentrations in DRC, specifically copper, lead and zinc, were higher than those at 47c ecoregion REMAP sites (**Appendix 2; Figures 2-3 to 2-8**). However none of these exceeded consensus based threshold levels set forth by MacDonald (*et. al.* 2000).

Pyrene, a chemical found in coal tar and is used to produce plastics, dyes and pesticides, was found in three of the four sediment samples at levels exceeding consensus based sediment quality guidelines set forth by MacDonald (*et. al.* 2000). The threshold value for ecological impact put forth by this study recommended a pyrene concentration of 195 µg/kg. Sediment at site DRC 1 was found to have a pyrene concentration of 510 µg/kg. Sediment samples at site DRC 4 had concentrations of 940 and 330 µg/kg on two separate sampling dates. Relating data collected during sediment sampling to in-stream biological conditions is difficult given that only two sites were sampled for sediment. BMIBI & FIBI scores observed at the two sites were not significantly different (**Appendix 2; Tables 2-19 & 2-20**). Neither the additive nor synergistic impacts of the array of chemicals present in DRC can be quantified. The complicated web of interactions that occur among and between these chemicals and the organisms in DRC cannot be untangled. It is likely that the combined effects of the pesticides, metals and other chemicals are having an adverse impact on biota attempting to inhabit this system.

Though it was not within the scope of this investigation to assess the stream for human health concerns, it should be noted that potentially hazardous conditions exist in DRC. Several chemicals, including a pesticide and wood preservative, Pentachlorophenol; a degreasing agent, Tetrachloroethene and a PVC byproduct, bis(2-ethylhexyl)phthalate, were found at levels above recommended human health thresholds (**Appendix 2; Tables 2-8 & 2-9**). Of particular concern is the PVC byproduct bis(2-ethylhexyl)phthalate that was found at levels well above EPA drinking water and fish consumption values in every storm event an analysis was performed for the parameter. In one storm event the byproduct occurred at a concentration of 150 µg/L. The EPA recommended bis(2-ethylhexyl)phthalate threshold values for drinking water and fish consumption are 1.2 & 2.2 µg/L respectively. On that date the PVC byproduct concentration was 68 times the fish consumption criteria and 125 times the drinking water criteria. Although Dry Run Creek is not designated as a drinking water source, it is alarming to find bis(2-ethylexyl)phthalate (a chemical known to cause reproductive problems) concentrations this high in any water body.

4.2 Increased Suspended and Bedded Sediment

Several sediment-related indicators provide evidence of sedimentation as a primary stressor in the DRC biological impairment. Embeddedness is the degree that coarse rock substrates such as gravels, cobbles, and boulders are surrounded or embedded within fine sediment particles. Embeddedness is often evaluated in riffles or shallow runs where current velocities are normally high enough to prevent excessive fine sediment accumulation. As sediment loading increases, the large and small spaces between rocks become filled with fine sediment particles, making this important habitat niche less suitable for invertebrates and fish that utilize it for feeding, shelter, spawning, and egg incubation.

The examination of stressor-response plots from Iowa streams indicated embeddedness ratings above 3.0 (40-60%) are associated with a higher probability of FIBI levels considered biologically impaired in the Iowan Surface (47c) ecoregion. There is strong evidence that embeddedness occurs at levels consistent with impairment at multiple locations in the DRC watershed. The embeddedness rating for the two full biocriteria sampling sites, DRC 1 & DRC 4, was 4.0 and 3.5 respectively. This numeric range is equal to about 50-70 percent embedded. The ecoregion reference site 75th percentile embeddedness rating is 2.53, which is roughly equivalent to 30-50 percent. Simple scatter plots of embeddedness rankings from 47c ecoregion reference sites and DRC sites clearly show that DRC sites have higher embeddedness rankings than any reference site in the 47c ecoregion (**Appendix 2; Figure 2-2**).

Qualitative embeddedness ratings at 13 RBP sites ranged from poor to sub-optimal with a median rating of marginal (50-75%). On the stressor checklist, field staff rated embeddedness as excessive at five of the 13 (38%) sites. These sites were located along the main stem and on two out of the four tributaries to DRC. DR1 and DR4 levels for several data metrics that relate directly to the suitability of coarse rock substrates to support benthic macroinvertebrate taxa and fish species that require un-embedded rock substrates for habitat, feeding or reproduction were lower than ecoregion reference site expectations. These include: SH Ephemeroptera Pct; SH Scraper Pct.; number Benthic Fish Sp. and percent Simple Lithophilous Spawners (**Appendix 2; Tables 2-21 & 2-22**). Among RBP sample sites, the number Benthic Fish Sp. metric was evaluated as not comparable to reference expectations at six of 13 sites (46%) (**Appendix 2; Tables 2-23 & 2-24**).

Silt is fine-grained, unconsolidated sediment that usually covers only a small amount of the stream bottom in healthy stream systems. For example, the interquartile range for 47c reference sites is 4-20 percent. Silt is easily suspended and transported downstream therefore, it is usually found along the margins of streams and in stagnant pools. Silt can be a significant component of turbidity reducing water clarity for sight feeding fish. As silt settles to the bottom, it smothers aquatic habitat and interferes with biological processes such as organism respiration, spawning and egg incubation, and photosynthetic production.

The examination of stressor-response plots from Iowa streams suggests that as silt levels increase above 20 percent there is an increased occurrence of BMIBI and FIBI levels considered biologically impaired in the 47c ecoregion. The percent stream bottom as silt estimated at two full biocriteria sampling sites ranged from 7 -11 percent with a mean of nine percent. These values fell within the interquartile range of 47c ecoregion reference sites. Contrary to what was seen on sites DRC 1 and DRC 4 observations at RBP sites indicate that silt covered stretches of stream are widespread in the DRC watershed. Six of 13 (46%) RBP sites had silt covering much of the stream bottom, including rock substrates. Three out of the four tributaries that contained an RBP sampling site were represented by this evaluation. These data show that excessive siltation occurs across the watershed but not consistently at all sites, indicating that streambed sediment characteristics are likely controlled by reach scale flow conditions and availability and type of local sediment sources.

Typically, systems impacted by bedded sediments are also impacted by suspended sediments. The indicators for suspended sediment are total suspended solids (TSS) and turbidity. Values for TSS and turbidity found at the 10 water quality monitoring sites in DRC (**Figure 9**) fell below the 75th percentile levels for 47c ecoregion reference sites (**Appendix 2; Tables 2-4 & 2-5**). Reference values for TSS and turbidity are derived from base flow sampling conditions at the ecoregion reference sites. It is likely that due to the flashy nature of DRC, most of the suspended sediment load is transported during peak discharge events. The silt is moved downstream into the Cedar River, leaving a sediment load dominated by heavier sands which quickly re-deposit during base flow conditions. Observations by field crew members during RBP sampling showed at least one of the following: excessive sediment bar development, shifting sand, or excessive scouring at eight of 13 RBP sites. This qualitative data is evidence that fine particle movement, especially sand, during storm events is a potential stressor of the biotic community.

Studies have shown that excessive scouring by fine particles can have direct impacts on organisms through reduction in feeding and reproductive efficiency, drift and direct mortality (Wood and Armitage 1997). Increased sand load can also have indirect effects, such as the scouring of periphyton. This reduces the food available to invertebrates in the scraper feeding guild thereby reducing diversity and abundance in the stream. Biggs et.al. (2000) found that sediment instability greatly increased disturbance intensity of periphyton. Sediment data available in this investigation was incomplete; an assessment of sediment loading characteristics (sand vs. silt) was not possible and any declaration of the impact on the biota is qualitative in nature. Additional sediment sampling, including deposited and suspended (storm event) sediment particle analysis, should be included in future monitoring plans for this stream system.

Data from the two full biological sites show that percent composition of sand, silt, gravel and cobble fall within the expected range for 47c reference stream sites. However, information from the RBP network of sites (**Figure 8**) indicates that problems may occur locally within the stream system. At two of 13 sites there was excessive sediment bar development and in three of 13 sites, excessive substrate instability and shifting sand was noted (**Appendix 2; Table 2-33**). These observations may be a function of localized flow instabilities rather than excessive sediment delivery, none-the-less substrate instability could potentially stress biota on a local scale. Impacts associated with shifting and unstable substrate are discussed in more detail in section 4.1 on altered flows.

Channel bedform composition (percent pool, riffle, and run) at the two full bio sites differed greatly from one another. At DRC 4 (**Figure 8**) the riffle, pool, run percent breakdown fell very close to the expected range associated with the 47c reference stream sites however, DRC 1 differed greatly with only three percent pool, two percent riffle and 95 percent run. Additionally, average pool depth was observed to be a problem at DRC 1. With an average pool depth of only 0.5 feet in 2005, the site fell below the expected range of average depth observed at 47c reference sites. Correspondingly, the observed number of sucker species (2), which inhabit deep areas of streams, was lower than the minimum expectation for reference sites (3.4). The channel bedform characteristics noted at DRC 1 are largely anthropogenic in nature as the site was subject to ditching in the past. However, differences at site DRC 1 between the 1999 and 2005 full biological sampling in average thalweg and average transect depth indicate sediment deposition contributes to the decreased channel/pool depth. In 1999 average thalweg depth was 2.56 ft while in 2005 thalweg depth averaged 1.84 (**Appendix 2; Table 2-30**). Additionally, the number of sucker species collected during the 1999 sampling was higher (3) than collected in 2005 (2).

The sediment indicators evaluated at RBP sites provide evidence suggesting that reach-scale sediment deposition and pool filling are potentially significant stressors to the aquatic community. The sediment deposition rating ranged from poor to sub-optimal with a median rating of marginal (30-50% stream bottom affected). In the stressor field checklist, three of 13 (23%) rapid bioassessment sites were evaluated as having significant reduction of pool depth due to sedimentation (**Appendix 2; Table 2-33**). Two of the three sites were located in the urbanized sections of the watershed. The RBP sites offer a broader perspective of conditions in the watershed including stream reaches located near the headwaters where sediment delivery rates are often higher. The RBP evidence generally supports the determination that sedimentation impacts are a major contributing factor in the DRC biological impairment.

Potential sources of sediment in the watershed include: storm water runoff from construction sites and urban areas, sheet and rill erosion from agricultural fields, gully erosion, and stream bed/bank erosion. The estimated potential sheet and rill erosion based on 2007 land cover and soil survey data is 23,114 tons/year. Using a sediment delivery ratio of 12 percent (value for the Iowan Surface land form region) yields total overland soil delivery to the stream of 2,752 tons/year (**Appendix 2; Figure 2-14**). The lower section of DRC contains the oldest sections of Cedar Falls; soil mapping data was unavailable in these 2,530 acres of the watershed. It is likely that with the exception of construction sites, very little sediment is moving in this area of the watershed. The average sediment delivery rate in the DRC watershed is 0.22 tons/acre/year. The areas of highest sediment delivery potential are construction sites located in the mid sections of the watershed, in the rapidly developing areas of Cedar Falls (**Figure 3**). These areas of construction have the potential to contribute significantly to the sediment load of

DRC, especially on a reach scale. Estimates of soil loss from these areas were made using no control structures so estimates are a worst case scenario. There was approximately 500 acres of active construction in the DRC watershed during 2007. Given the rate of growth in recent years, this number is unlikely to decrease in the near future. The estimate for total sediment delivered from the 500 acres of active construction is 1.7 tons/acre/year. This accounts for over 890 tons of the sediment delivered to DRC from sheet and rill erosion on an annual basis. This means that over 32 percent of the estimated sediment contribution from upland sources is delivered from only four percent of the total area. Given the close proximity of many construction sites to DRC it is likely that these activities significantly impact the stream at a local scale.

Evidence of streambed and bank erosion in the DRC watershed is mixed, as is expected in a meandered stream system. Stream bank stability and vegetative conditions in some stream reaches were rated as relatively good and in other areas they were rated as poor. Excessive bank erosion/sloughing was reported at only two of 13 (15%) rapid bioassessment sites and appeared to only be a problem at one of the two full biocriteria sampling sites (**Appendix 2; Table 2-32**). At DRC site 4, the percentage area of vertical stream bank (55-110 degree slope), which might be considered the most vulnerable to erosion and sloughing, averaged 30 percent (range: 10-50), slightly higher than the 75th percentile (27.5%) for regional reference sites. Additionally, DRC 4 had elevated levels of undercut streambank (115-180 degree slope), with an average of 10 percent, this site fell above the 47c ecoregion 75th percentile value of 2.5 percent.

Streambanks along this site may be considered unprotected by vegetation as average bare bank exposure was 81%, above the 75th percentile value for the 47c ecoregion (75%). This site has heavy tree cover; average channel shading was 98 percent. It is possible that streambanks which appear bare due to lack of herbaceous vegetation may in fact be stabilized by tree roots. This would explain the higher than expected occurrence of undercutting on relatively bare streambanks. Information gathered at DRC 4 indicates that streambank erosion is a potentially significant local source of sediment (**Appendix 2; Table 2-31**). Conversely, data collected from DRC 1 showed minimal problems associated with streambank erosion (**Appendix 2; Table 2-30**). At DRC 1 the values for vertical bank, undercut bank and percent bare bank (10%, 0%, & 61% respectively) fell within or below the interquartile range for 47c ecoregion reference sites. These observations indicate that actual onsite streambank conditions are highly variable within this stream system.

Information collected during a stream channel analysis project conducted by the Environmental Geology program at the University of Northern Iowa was used to assess the condition of streambanks within the DRC channel system. An analysis of the data collected during the assessment shows the percentage of total stream length, by stream order, classified as having moderately unstable to unstable streambanks is highest in the second order sections of the stream network (66%) followed by first order tributaries (39%) and then by the main stem or third order (35%) (**Appendix 2; Table 2-34**). The unstable to moderately unstable streambanks in the second order areas have an average height of around five feet and account for roughly 30,000 ft worth of stream channel or about 19 percent of the total stream length (155,000 ft). The estimated surface area of the potentially severely eroding streambank in these areas is 300,000 ft^2. The stream length in first order tributaries classified as having unstable to moderately unstable streambanks averaged five feet high and had a total length of roughly 35,000 ft (23% of total channel length). Using the same calculation as the second order sections yielded a total surface area of potentially severely eroding streambanks of roughly 350,000 ft^2. Unstable to moderately unstable streambanks averaged nine feet in height along the main stem of DRC. The total surface area of these streambanks was roughly 58,000 ft^2. From a potential sediment source ranking the streambanks along the third order sections of this watershed are a relatively minor contributor. Taken as a whole, streambank derived sediment appears to be most problematic in the first and second order tributaries of DRC.

A comparison of the data from the first and second order tributaries unveils a potentially important trend. As expected, the total stream length represented by first order stream is over double that of second order (94,000 ft to 44,000 ft). However, the length of channel classified as having unstable streambanks only differed by fifteen percent between the two. This indicates that the streambank derived sediment in second order sections of the stream network has a higher potential to cause localized sedimentation problems. These data displayed visually clearly show a hot spot for potentially severe streambank erosion along the southeast branch, specifically within sub-watersheds 1 and 4 (**Figure 12**). The RBP site, DRC15, located directly downstream of this area, was observed to have the highest RBP rankings for percent embeddedness (>75%) and percent channel impacted by sediment deposition (>50%). Site DRC 15 ranked among the lowest average metric fish and average total metric scores (**Appendix 2; Table 2-23**). Urban development data indicate that areas in and upstream of these two sub-watersheds have experienced a rapid expansion of urban land use in the last 10 years (**Figure 12**). The increased frequency of unstable streambank conditions in this area are likely a direct response to increased storm water runoff and increases in flow velocities & volumes. It is likely that expansion of the Cedar Falls area will continue in this area of the watershed. Without widespread adoption of urban storm water Best Management Practices (BMP's) in this rapidly urbanizing area, geomorphic condition in the south east branch will likely continue to degrade, further stressing in-stream biota.

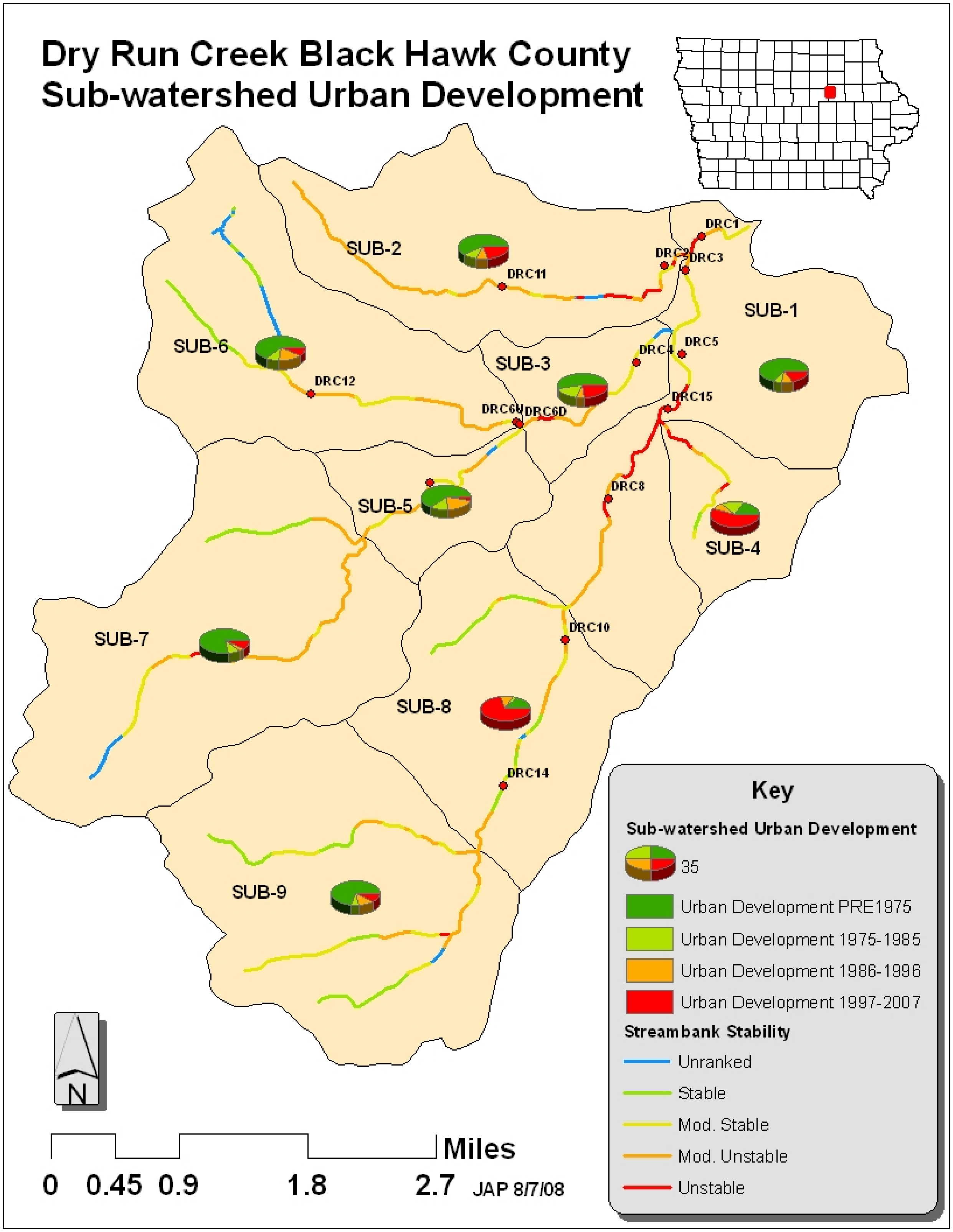

Figure 12 Dry Run Creek sub-watershed urbanization and streambank stability rankings

5. Secondary Causes

5.1 Dissolved Oxygen

Depending on the duration and severity, reduced levels of dissolved oxygen (DO) can have a significant impact on aquatic life. Organisms subjected to low DO concentrations may undergo acute mortality or suffer from chronic stresses, which result in diminished biological functions and downstream drift. Monitoring data collected in DRC over a three year period showed that a low DO problem may exist. Monitoring data from 2006 through the spring of 2008 showed no apparent problems with low DO. However, in 2005, several samples indicated that problems may exist.

The impaired segment of DRC (**Figure 1**) is designated for Class B (LR) "Limited Resource" warmwater aquatic life uses. DO levels for streams with this designation must remain above 5 mg/L for at least 16 hours per day and levels must not fall below 4 mg/L at any time. Water quality monitoring site DRC 6 (**Figure 9**) had DO levels fall below 4 mg/L on two occasions (3.5 and on 7/21/05 and 3.4 mg/L 8/11/05). While actual water quality violations were recorded at DRC 6 on two occasions, potential problems were not limited to this location. There were five sampling dates in 2005 where DO values were recorded at 5 mg/L or less on at least one site (**Table 7**). On 7/21/2005, five sites on the main stem and the southeast and southwest branches of DRC were found to have DO concentrations below 5 mg/L (**Appendix 2; Figure 2-19**), indicating the condition was watershed wide. Dissolved oxygen levels in aquatic systems commonly undergo diurnal shifts in response to community respiration. These diurnal shifts result in the lowest DO concentrations in the early morning around dawn and then rebound as photosynthesis commences. The DO levels monitored in DRC were collected during water quality grab sampling and represent the concentrations at a single point in time. Since sampling was conducted during the daytime hours it can be assumed that actual night time low DO concentrations in DRC were lower than values recorded at the time of sampling. Unfortunately diurnal DO data collection was not conducted during the monitoring of this watershed. The duration that DO levels were below 5mg/L and the actual night time low DO concentration could not be determined.

Conditions contributing to the low DO values recorded throughout the watershed in the summer of 2005 could not be determined from our data set. It is possible that high Biological Oxygen Demand (BOD) loads entered the stream during the warm water months (early July through mid September), depressing in-stream DO concentrations (BOD5 was not monitored in 2005). Some data exist that indicate the stream could be subject to intermittent influxes of materials with a high BOD. During the melt water sampling on 3/13/2008, six of the ten water quality sites (**Figure 9**) had BOD5 values which were higher than 21 mg/L (**Appendix 2; Table 2-13**). The actual BOD5 concentrations could not be determined on these samples as all available oxygen in the sample had been depleted before analysis could be completed. This information indicates conditions that may result in depressed DO concentrations exist. However, DO concentrations taken during melt water sampling were near or above 100 percent saturation. The cold water temperatures and re-aeration from turbulent flows allowed dissolved oxygen levels to remain steady despite the increased BOD load. It is possible that in-stream DO concentrations could be depleted if this influx of BOD were to occur during lower flows and at higher temperatures.

Table 7 2005 low dissolved oxygen concentrations and % saturations

Site		06/23/05	07/21/05	08/11/05	09/22/05	10/05/05
DRC 1	DO	6.6	4.8	-	9.3	9.8
	% saturation	72	57	-	102	109
DRC 4	DO	4.9	6	-	7.1	9.3
	% saturation	56	57	-	102	109
DRC 5	DO	5.2	4.7	-	5	11
	% saturation	63	58	-	57	128
DRC 6	DO	4.3	3.5	3.4	-	4.9
	% saturation	51	43	40	-	57
DRC 7	DO	5.5	4.9	-	-	-
	% saturation	56	55	-	-	-
DRC 8	DO	5	5.1	4.5	6.5	6.5
	% saturation	60	64	51	74	74
DRC 9	DO	4.8	5.2	5.8	6.5	6.5
	% saturation	53	59	68	73	73
DRC 10	DO	5.2	4.2	-	8.7	8.7
	% saturation	61	51	-	74	74

The extent to which depressed DO levels contribute to the impairment could not be determined using available data. Given the lack of diurnal data collection and the absence of water quality violations during last two and a half years of sampling, it is the determination of the SI team that a TMDL should not be calculated for dissolved oxygen. Any future monitoring of this water body should include more extensive, continuous DO data collection.

5.2 Un-ionized Ammonia

Un-ionized ammonia is directly toxic to aquatic invertebrates and fish. Iowa has water quality standards which set criteria designed to protect aquatic life against acute or chronic toxicity from un-ionized ammonia. The criteria are expressed as total ammonium ion concentration from which un-ionized ammonia concentration can be determined as a function of pH and temperature. For a given concentration of total ammonium ion, an increase in pH and/or temperature will result in an increase in un-ionized ammonia concentration. During more than three years of bi-weekly grab sampling and storm event sampling no ammonia violation were recorded. However, during melt water sampling conducted on 3/13/2008 (**Appendix 2; Table 2-13**) two sites, DRC 9 and DRC 10, recorded ammonia levels of 1 mg/L which were violations of the states chronic toxicity water quality standards. The reason for a violation of the chronic threshold was due mostly to the elevated pH at the two sites. The pH values at DRC 9 and DRC 10 were 8.6 and 9 respectively, exceeding the water quality standard for pH. Given the data collected during the assessment phase of this project, it is unlikely that elevated ammonia levels contribute significantly to the impairment in this watershed. Due to the episodic nature of ammonia spikes in stream systems, it is possible that our monitoring network missed short duration increases in ammonia. It is recommended that any future water quality monitoring plans include a screening for ammonia levels in the stream.

5.3 Altered Daily or Seasonal Flows and Temperatures

The southwest branch of DRC runs through the University of Northern Iowa campus where multiple coolant water outfalls discharge to the stream. The University of Northern Iowa's

NPDES permit contains 27 outfalls that are permitted to discharge non-contact coolant water to DRC. The combined permitted flow contribution of all 27 outfalls is 23,160,393 gallons per day. The water flowing from these outfalls originates from ground water aquifers in the area and is primarily used in cooling towers at the UNI power plant and in cooling systems of buildings throughout campus. Observations noted during a stream corridor assessment along the southwest branch of DRC indicated that many pipes flow into DRC even during dry conditions. The field crew noted and marked the location of ten outfall pipes contributing flow to DRC in the area around UNI (**Appendix 2; Figure 2-16**).

Despite the presence of several coolant water inputs to the stream, there was little evidence to suggest that either flow or temperature alterations associated with the inputs have a significant impact on the streams biological community. Mean and median stream temperature values taken at DRC water quality monitoring sites between the dates of 7/1 and 10/31 in each monitoring year (**Appendix 2; Table 2-4**) fell within the 47c ecoregion reference site inner quartile range of water temperatures (**Appendix 2; Table 2-5**). High temperatures from water quality monitoring sites (**Appendix 2; Tables 2-1 to 2-3)** also fell well below Iowa's water quality standard of 30 ºC. Additionally, event monitoring on sites DRC 1 and 4 uncovered no temperature readings above 30 ºC (**Appendix 2; Tables 2-8 & 2-9**). While it is possible that sections of DRC may be subject to rapid increases in temperatures due to elevated temperatures of storm water inputs, monitoring did not uncover such data.

Three possible reasons for this exist. First, it is possible that DRC is not subject to increases in temperature from storm water inputs but this is highly unlikely. Second, the data collection scheme was not suited for monitoring spikes in temperature. Temperature data collection during the storm events was conducted by hand when field staff retrieved samples from the unit, usually a full 24 hours after the initial event occurred. If rapid rises in stream temperatures were to occur in response to an influx of storm water runoff from hot pavement, it would happen early in the event. By the time field staff reached the sites increases in temperature would have been missed. Continuous temperature monitoring should have been a part of the initial monitoring design. Third, ISCO storm event samplers were located on the southwest branch (near coolant water inputs) and on the main stem near the bottom of the watershed; no storm events were collected on the southeast branch where many parking lots and industrial sites were located. The inputs of coolant water in and around the areas where event sampling took place could have offset any temperature increases in the area. Event temperature monitoring should have included the southeast branch of the stream as this was an area where increases in stream temperatures would be expected.

Weekly minimum and maximum temperature data (**Appendix 2; Table 2-18**) collected during a UNI study (**Appendix 4**) showed some possible muting of diurnal temperature fluctuations. The degree to which this impacts biota in DRC is unknown. Additionally, flow data collected in the areas around the University was insufficient to determine the impacts on the biotic community. Highly urbanized systems are known to have decreased base flow conditions due to a decrease in infiltration and ground water recharge. Our data indicate that in the areas downstream of coolant water discharges no such depletion of base flow exists. It is possible that the coolant water actually helps to alleviate the potential lowering of baseflow expected in an urbanized area. Given the isolated area of the stream impacted by coolant water discharges and the poor biological conditions found in areas that do not receive these discharges, it is unlikely that changes in temperature and flow associated with these outfalls significantly contributes to the impairment on DRC.

5.4 Chlorine

Chlorine, a chemical that quickly volatilizes or transforms into ionic states, is not a normal constituent of stream water. When introduced to the aquatic environment it can cause acute toxicity in stream organisms. Even doses that do not result in direct mortality of invertebrates or fish can cause significant die off in periphyton and algal communities, resulting in an unbalanced food web, altering community composition. It is possible that chlorine inputs capable of causing acute mortality and/or periphyton die off currently occur or did occur leading up to TMDL biological sampling. Of the ten water quality monitoring sites in DRC, three had water column chlorophyll a samples taken (**Appendix 2; Table 2-4**). Sites DRC 1, 4 and 6 had median chlorophyll a values of two, one and three µg/L respectively. These values fell below the inner quartile range for 47C ecoregion REMAP sites of 5 – 32 µg/L. This data suggests that primary production could be depressed in this stream system. However, two RBP sites located in the area expected to receive coolant water discharge from UNI buildings (DRC 2 and DRC 6D2) were observed to have excessive filamentous algae growth, indicating that primary production was not limited by chlorine inputs.

In the winter of 2005-2006, it was noted by field staff that the smell of chlorine could be detected around an outfall immediately upstream of DRC 4 (**Figure 8**). On several occasions water samples taken from the outfall and in the stream were tested for chlorine. The outfall had Total Residual Chlorine (TRC) values near one mg/l and the stream had values around 0.5 mg/l. Iowa's water quality standards set the chronic and acute toxicity levels for TRC at 11 and 19 µg/l for aquatic life uses. The TRC values found in the stream (.5 mg/l or 500 µg/l) were over 26 times the acute toxicity level in Iowa's water quality standards. Upon investigation by field staff from the DNR Environmental Service section, it was determined that an un-permitted discharge of chlorinated drinking water was entering DRC. Under Iowa Administrative Code (Chapter 576-62.1(455B) Prohibited Discharge), "*The discharge of any pollutant from a point source into a navigable water is prohibited unless authorized by an NPDES permit.*" It was determined that approximately 50 gallons/minute of drinking water (containing measurable chlorine) was continuously discharging from the Nazareth Lutheran Church into DRC directly upstream of DRC 4. This facility was issued an NPDES permit (permit # IA0080047) for the discharge to DRC on 2/26/2007. The permit assigned a maximum daily concentration for TRC of 1.07 mg/l and a maximum daily mass of 0.14 lbs per day. The levels of chlorine discharged from Nazareth Lutheran Church to DRC are not known to be acutely toxic to in-stream biota, though it is likely that chlorine adds stress to an overstressed system.

An ecological evaluation of DRC was conducted by Dr. Kurt W. Pontasch of the Department of Biology at the University of Northern Iowa and was submitted to the IDNR in the fall of 2007 (**Appendix 4**). One of the goals of this investigation was to determine if outfall effluents have an impact on the stream invertebrate community. Effluent toxicity testing was done on select outfalls from May 2006 through April of 2007 (**Appendix 2, Figure 2-27**). The results showed that multiple coolant water outfalls contained effluent that could be lethal to stream organisms. A total of five coolant water outfalls were found to contain toxic effluent (**Appendix 2; Table 2-29**). The UNI towers discharge on the northwest branch was found to be toxic on five occasions, the Spearman-Karber LC50 ranged from 4.375 to 61.875 percent effluent. The Tall Grass Prairie outfall, just upstream of DRC 4, had the lowest Spearman-Karber LC50 with only 3.75 percent effluent resulting in mortality. The effluent toxicity in this investigation was attributed to chlorine. The authors of the document stated that, "*One of the first steps in a*

Toxicity Identification Procedure is to aerate the effluent for 24 hours, and then test for toxicity again. Every toxic effluent found in this study was nontoxic after aeration. This coupled, in most cases, with a strong odor, suggests that chlorine is the likely source of toxicity in these effluents".

No chlorine concentrations were obtained by the UNI study; therefore a direct, quantitative link between chlorine and toxicity could not be made with the information provided in the Ecotoxicological Evaluation. Despite the lack of quantitative data, ample qualitative observations point toward chlorine as the cause of effluent toxicity. During a meeting in the winter of 2007-2008, members of the UNI facilities team were informed of the potential contribution of chlorine to the toxicity of coolant water outfalls on campus. In response to the meeting UNI took several actions. First, UNI started updating the maps of storm water and coolant water lines on campus. Second, UNI began identifying and correcting any potential chlorine inputs to the system. In the spring, UNI staff identified a pond (used for watering landscaping) that maintenance staff periodically shocked with chlorine to stave off algal blooms. Managers directed staff to avoid chlorine treatments of the pond. In the early summer of 2008, facilities staff discovered that maintenance staff had historically been treating fountains on campus with chlorine in order to control algae growth; this practice has been eliminated. None of these practices provided a continuous flow of chlorine to the stream but could have contributed to the intermittent toxicity of certain outfalls around the campus area. UNI staff continues to work toward identifying and correcting any practices that may result in the addition of chlorine to the coolant water/storm water discharge locations.

The potential inputs of chlorine to DRC are being addressed through NPDES permit compliance steps and voluntary changes in management practices. Facilities managers at UNI are actively working to identify and stop any additional chlorine inputs that may exist. These actions, coupled with the lack of known chlorine inputs in other sections of DRC where poor biological conditions persist, indicate that chlorine, while a contributor, should not be considered one of the major stressors in DRC. IDNR SI team staff recommends that DNR work with UNI to perform additional monitoring of coolant water outfall toxicity and chlorine concentrations at all coolant water outfalls around campus. These actions would help UNI staff to determine if all chlorine inputs to the system have been located and will allow UNI to display that they have eliminated toxicity problems in the coolant water discharge system. Other discharge sources of coolant water in the watershed should be identified and assessed to determine their potential contribution to aquatic life impairment.

6. From SI to TMDL

Because the SI process was initiated pursuant to Iowa's Section 303(d) listings for biological impairments with unknown causes, the primary stressors determined by the SI are communicated in terms of standard cause and source codes as specified in U.S. EPA guidance for the 2004 Integrated Report and the IDNR 305(b) assessment protocol (IDNR 2005). The 305(b)/303(d) candidate cause list is shown in **Table 8**.

The primary stressors identified by this SI translated into 305(b)/303(d) cause codes are: Siltation (1100); Flow alteration (1500); and Other habitat alterations (1600).

Table 8 The candidate causes with associated cause codes as used by the 305(b) assessment/303(d) listing methodology

Cause Code	Cause Name	Cause Code	Cause Name	Cause Code	Cause Name
0	Cause Unknown	570	Selenium	1300	Salinity/TDS/Chlorides
100	Unknown toxicity	580	Zinc	1400	Thermal modifications
200	Pesticides	600	Unionized Ammonia	1500	Flow alteration
250	Atrazine	700	Chlorine	1600	Other habitat alterations
300	Priority organics	720	Cyanide	1700	Pathogens
400	Non-priority organics	750	Sulfates	1800	Radiation
410	PCB's	800	Other inorganics	1900	Oil and grease
420	Dioxins	900	Nutrients	2000	Taste and odor
500	Metals	910	Phosphorus	2100	Suspended solids
510	Arsenic	920	Nitrogen	2200	Noxious aquatic plants
520	Cadmium	930	Nitrate	2210	Algal Growth/Chlorophyll a
530	Copper	990	Other	2400	Total toxics
540	Chromium	1000	pH	2500	Turbidity
550	Lead	1100	Siltation	2600	Exotic species
560	Mercury	1200	Organic enrichment/Low DO		

6.1 Cause Elimination and Evidence Uncertainty

It is important to remember the SI process uses a weight of evidence approach that is not synonymous with dose-response experimental studies. Therefore, the conclusions reached in this SI must be viewed cautiously with the understanding that correlation and association do not necessarily prove cause and effect.

One of the larger uncertainties in this SI results from the fact the available data were spatially and temporally limited. Because of these limitations, the importance of certain stressors either could have been downplayed or inflated. For example, data were not adequate to support a quantitative analysis of some primary stressors in the southeast branch of DRC. Biological sampling from the southeast branch was limited to RBP samples, making analysis of certain BMIBI & FIBI metrics impossible. This, coupled with the lack of certain water quality parameters (continuous and grab sample flow data, chlorophyll a, and continuous DO) made temporal comparisons of biological conditions and associated flow and water quality attributes difficult. Qualitative observations from the southeast branch of DRC indicated that elevated flows contributed significantly to the depressed biotic conditions in the southeast branch. Quantitative data would have strengthened these associations.

Another source of uncertainty is the lack of appropriate benchmarks or criteria for evaluating the significance of some proximate stressors or causal pathway indicators. The process is also limited by a lack of readily available data analysis techniques that could help identify useful patterns and associations in the data set. There is also uncertainty associated with ranking the relative importance of primary stressors. In this SI, it is assumed that each primary stressor is individually capable of causing the biological impairment. However, some stressors are known to exert a greater detrimental impact upon certain aspects of stream biological health than others. For example, certain benthic-oriented metrics of the fish IBI are known to respond more strongly to sedimentation impacts than other types of stressors. These subtle distinctions are not handled well in the current SI process. As the IDNR gains more experience and refines the SI process, sensitivity and confidence levels should continue to improve.

A number of candidate causes/stressors were excluded from consideration based upon best professional judgment and knowledge of the watershed. These causes/stressors were all ranked as having a low probability of contributing to the stream biological impairment (**Table 4**). If management actions designed to alleviate the primary causal agents identified in this SI fail to restore the biological community to unimpaired status, the evidence will again be reviewed and any excluded causes/stressors may be reconsidered. An excluded candidate cause/stressor might also be reconsidered if new data or information provides compelling evidence the cause/stressor plays an important role in the impairment.

7. Conclusions

Despite some data limitations, the evidence was sufficient to identify the following primary stressors, any of which is capable of causing biological impairment in the DRC watershed:

- Elevated levels of silt accumulation and sedimentation of rock substrates
- Decreased macro and micro habitat complexity and availability
- Increased urban storm water inputs and changes in hydrology

Depending on the causal mechanism, primary stressors can manifest as short-term acute impacts or long-term chronic impacts to aquatic biota. To restore the biological condition of the stream to un-impaired status, TMDL and implementation plans need to address each of the primary stressors and multiple causal pathways that occur in the watershed.

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9. Appendices

Appendixes

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First Appendix: Methods

A. Reference Sites

Reference sites in Iowa represent contemporary stream conditions that are least disturbed by human activities. A number of important watershed, riparian and instream characteristics were evaluated as part of the reference site selection process (Griffith et al. 1994; Wilton 2004). Representation is also an important consideration. Reference sites strive to represent desirable, natural qualities that are attainable among other streams within the same ecoregion. As they are used in bioassessment, reference sites define biological conditions against which other streams are compared. Therefore, they should not represent stream conditions that are anomalous or unattainable within the ecoregion.

Currently, there are 96 reference sites used by IDNR for stream biological assessment purposes (Figure 1-1). Reference condition is the subject of a significant amount of research and development throughout the U.S. The IDNR will continue to refine Iowa's reference condition framework as new methods and technologies become available.

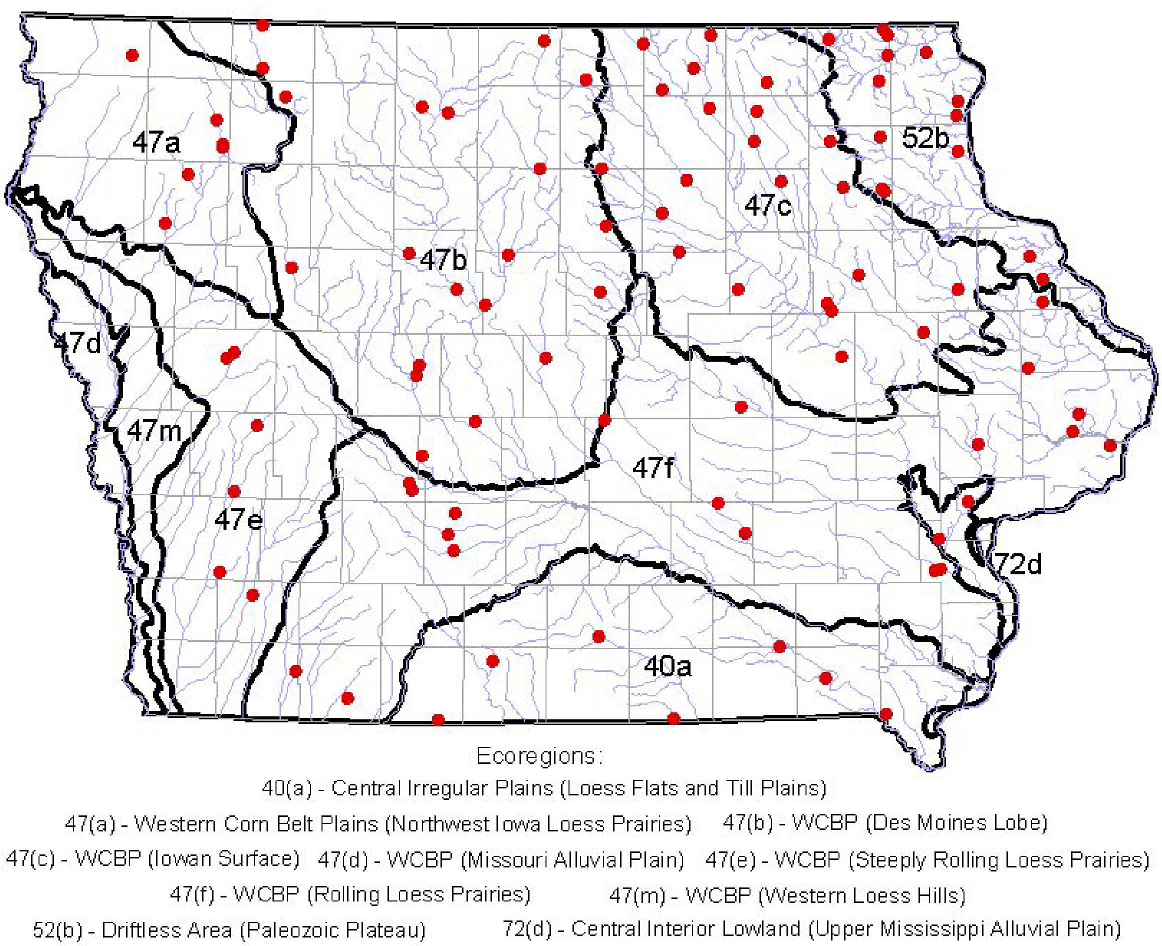


Figure 1-1 Iowa ecoregions and wadeable stream reference sites: 1994 – 2000

B. Sampling Procedures

Standard procedures for sampling stream benthic macroinvertebrates and fish assemblages are used to ensure data consistency between sampling sites and sampling years (IDNR 2001a, 2001b). Sampling is conducted during a three-month index period (July 15 – October 15) in which stream conditions and the aquatic communities are relatively stable. A representative reach of stream ranging from 150-350 meters in length is defined as the sampling area.

Two types of benthic macroinvertebrate samples are collected at each site: 1) Standard-Habitat samples are collected from natural rock or artificial wood substrates in flowing water; 2) a Multi-Habitat sample is collected by handpicking organisms from all identifiable and accessible types of benthic habitat in the sampling area. The multi-habitat sample data improve the estimation of taxa richness for the entire sample reach. Benthic macroinvertebrates are identified in the laboratory to the lowest practical taxonomic endpoint.

Fish are sampled using direct current (DC) electrofishing gear. In shallow streams, one or more battery-powered backpack shockers are used, and a tote barge, generator-powered shocker is used in deeper, wadeable streams. Fish are collected in one pass through the sampling reach proceeding downstream to upstream. The number of individuals of each species is recorded, and individual fish are examined for external abnormalities, such as deformities, eroded fins, lesions, parasites, and tumors. Most fish are identified to species in the field; however, small or difficult fish to identify are examined under a dissecting microscope in the laboratory.

Physical habitat is systematically evaluated at each stream sampling site. A series of instream and riparian habitat variables are estimated or measured at 10 stream channel transects that are evenly spaced throughout the sampling reach. Summary statistics are calculated for a variety of physical habitat characteristics, and these data are used to describe the stream environment and provide a context for the interpretation of biological sampling results.

C. Biological Indices

Biological sampling data from reference sites were used to develop a Benthic Macroinvertebrate Index of Biotic Integrity (BMIBI) and a Fish Index of Biotic Integrity (FIBI) (Wilton 2004). The BMIBI and FIBI are described as multi-metric or composite indices because they combine several individual measures or metrics. A metric is an ecologically relevant and quantifiable attribute of the aquatic biological community. Useful metrics can be cost-effectively and reliably measured, and will respond predictably to environmental disturbances.

Each index is comprised of twelve metrics that reflect a broad range of aquatic community attributes (Table 1-1). Metric scoring criteria are used to convert raw metric data to normalized scores ranging from 0 (poor) –10 (optimum). The normalized metric scores are then combined to obtain the BMIBI and FIBI scores, which both have a possible scoring range from 0 (worst) – 100 (best). Qualitative categories for BMIBI and FIBI scores are listed in Table 1-2. A detailed description of the BMIBI and FIBI development and calibration process can be obtained at the IDNR web page: http://www.iowadnr.com/water/tmdlwqa/wqa/streambio/index.html (Wilton 2004).

Table 1-1 Data metrics of the Benthic Macroinvertebrate Index of Biotic Integrity (BMIBI) and the Fish Index of Biotic Integrity (FIBI)

BMIBI Metrics	FIBI Metrics
1. MH*-taxa richness	1. # native fish species
2. SH*-taxa richness	2. # sucker species
3. MH-EPT richness	3. # sensitive species
4. SH-EPT richness	4. # benthic invertivore species
5. MH-sensitive taxa	5. % 3-dominant fish species
6. % 3-dominant taxa (SH)	6. % benthic invertivores
7. Biotic index (SH)	7. % omnivores
8. % EPT (SH)	8. % top carnivores
9. % Chironomidae (SH)	9. % simple lithophil spawners
10. % Ephemeroptera (SH)	10. fish assemblage tolerance index
11. % Scrapers (SH)	11. adjusted catch per unit effort
12. % Dom. functional feeding group (SH)	12. % fish with DELTs

* MH, Multi-habitat sample; SH, Standard-habitat sample.

Table 1-2 Qualitative scoring guidelines for the BMIBI

Biological Condition Rating	Characteristics of Benthic Macroinvertebrate Assemblage
76-100 (Excellent)	High numbers of taxa are present, including many sensitive species. EPT taxa are very diverse and dominate the benthic macroinvertebrate assemblage in terms of abundance. Habitat and trophic specialists, such as scraper organisms, are present in good numbers. All major functional feeding groups (ffg) are represented, and no particular ffg is excessively dominant. The assemblage is diverse and reasonably balanced with respect to the abundance of each taxon.
56-75 (Good)	Taxa richness is slightly reduced from optimum levels; however, good numbers of taxa are present, including several sensitive species. EPT taxa are fairly diverse and numerically dominate the assemblage. The most-sensitive taxa and some habitat specialists may be reduced in abundance or absent. The assemblage is reasonably balanced, with no taxon excessively dominant. One ffg, often collector-filterers or collector-gatherers, may be somewhat dominant over other ffgs.
31-55 (Fair)	Levels of total taxa richness and EPT taxa richness are noticeably reduced from optimum levels; sensitive species and habitat specialists are rare; EPT taxa still may be dominant in abundance; however, the most-sensitive EPT taxa have been replaced by more-tolerant EPT taxa. The assemblage is not balanced; just a few taxa contribute to the majority of organisms. Collector-filterers or collector-gatherers often comprise more than 50% of the assemblage; representation among other ffgs is low or absent.
0-30 (Poor)	Total taxa richness and EPT taxa richness are low. Sensitive species and habitat specialists are rare or absent. EPT taxa are no longer numerically dominant. A few tolerant organisms typically dominate the assemblage. Trophic structure is unbalanced; collector-filterers or collector-gatherers are often excessively dominant; usually some ffgs are not represented. Abundance of organisms is often low.

Table 1-3 Qualitative scoring guidelines for the FIBI

Biological Condition Rating	Characteristics of Fish Assemblage
71-100 (Excellent)	Fish (excluding tolerant species) are fairly abundant or abundant. A high number of native species are present, including many long-lived, habitat specialist, and sensitive species. Sensitive fish species and species of intermediate pollution tolerance are numerically dominant. The three most abundant fish species typically comprise 50% or less of the total number of fish. Top carnivores are usually present in appropriate numbers and multiple life stages. Habitat specialists, such as benthic invertivore and simple lithophilous spawning fish are present at near optimal levels. Fish condition is good; typically less than 1% of total fish exhibit external anomalies associated with disease or stress.
51-70 (Good)	Fish (excluding tolerant species) are fairly abundant to very abundant. If high numbers are present, intermediately tolerant species or tolerant species are usually dominant. A moderately high number of fish species belonging to several families are present. The three most abundant fish species typically comprise two-thirds or less of the total number of fish. Several long-lived species and benthic invertivore species are present. One or more sensitive species are usually present. Top carnivore species are usually present in low numbers and often one or more life stages are missing. Species that require silt-free, rock substrate for spawning or feeding are present in low proportion to the total number of fish. Fish condition is good; typically less than 1% of the total number of fish exhibits external anomalies associated with disease or stress.
26-50 (Fair)	Fish abundance ranges from lower than average to very abundant. If fish are abundant, tolerant species are usually dominant. Native fish species usually equal ten or more species. The three most abundant species typically comprise two-thirds or more of the total number of fish. One or more sensitive species, long-lived fish species or benthic habitat specialists such as suckers (Catostomidae) are present. Top carnivore species are often, but not always present in low abundance. Species that are able to utilize a wide range of food items including plant, animal and detritus are usually more common than specialized feeders, such as benthic invertivore fish. Species that require silt-free, rock substrate for spawning or feeding are typically rare or absent. Fish condition is usually good; however, elevated levels of fish exhibiting external anomalies associated with disease or stress are not unusual.
0-25 (Poor)	Fish abundance is usually lower than normal or, if fish are abundant, the assemblage is dominated by a few or less tolerant species. The number of native fish species present is low. Sensitive species and habitat specialists are absent or extremely rare. The fish assemblage is dominated by just a few ubiquitous species that are tolerant of wide-ranging water quality and habitat conditions. Pioneering, introduced and/or short-lived fish species are typically the most abundant types of fish. Elevated levels of fish with external physical anomalies are more likely to occur.

D. Plausibility of Stressor-Response Relationships

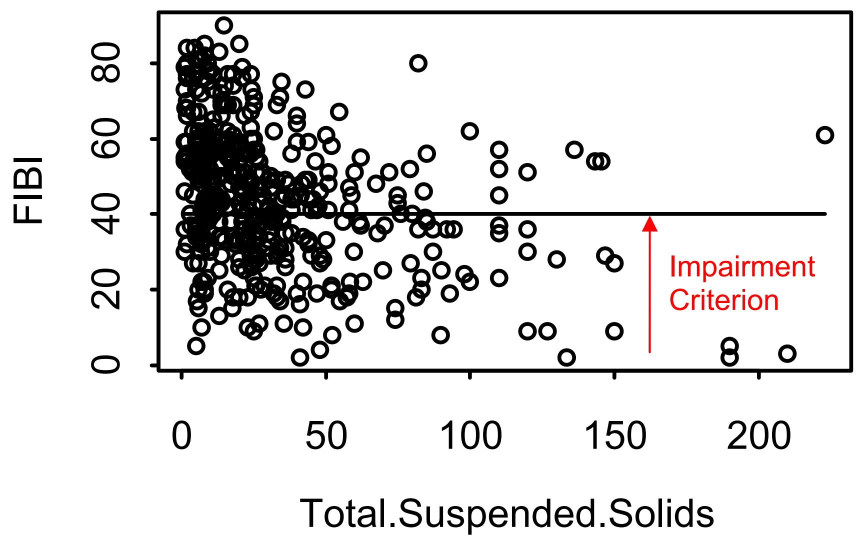
Graphical and quantitative analysis methods were used to examine the plausibility that various stressors occur at levels that are sufficient to impair the aquatic community of Silver Creek. The data analysis utilized biological and environmental indicator data collected primarily from wadeable streams during 1994-2003 as part of Iowa's stream biological assessment program. Scatter plots were created and visually examined to identify relationships between stressor indicators and biological response variables (i.e., benthic macroinvertebrate and fish IBIs). Regression coefficients were calculated to help identify stressor indicators that were significantly related with IBI levels. Examples of the scatter plot and simple regression analysis approach are displayed in Appendix 2 (Figures 2-2 – 2-10).

Conditional Probability (CP) is a promising technique for stressor-response analysis (Paul and McDonald 2004). This approach was used to evaluate SI data for the Little Floyd River, the North Fork Maquoketa River, and Silver Creek. CP computations were obtained for many stressor-response relationships, and the results were graphically displayed for visual interpretation (see Figure 1-2 [a-d]).

Essentially, the CP analysis method seeks to identify stressors that occur at levels associated with an increased probability of observing biological impairment. In the Little Floyd River example, biological impairment is defined as not achieving a BMIBI score or FIBI score that is greater than or equal to the impairment criteria established from regional reference sites in the Northwest Iowa Loess Plains (47a) ecoregion. For this ecoregion, the BMIBI criterion is 53 and the FIBI criterion is 40. Figure 1-2 shows the data analysis output from one stressor-response relationship (i.e., TSS-FIBI). Similar types of comparisons were made for stressor and causal pathway indicator data available for the Silver Creek watershed.

The example CP output shown in Figure 1-2 provides evidence of TSS as a primary stressor that is associated with impaired fish assemblage condition. Figure 1-2(a) shows the stressor-response pattern where increasing levels of the stressor (TSS) are generally associated with decreasing levels of the fish assemblage IBI. Figure 1-2(b) shows separation of the TSS Cumulative Distribution Function (CDF) for unimpaired sites compared with the CDF representing stressor levels at impaired sites. Generally, unimpaired sites have lower TSS levels than impaired sites. For example, the interquartile range of unimpaired sites is approximately 10-30 mg/L compared with 20-60 mg/L for impaired sites. Figure 1-2(c) shows CP computation output where the probability of observing impairment is plotted against stressor levels. At any given stressor level on the x-axis, the probability of impairment for sites where the stressor is less than or equal to the specified level can be obtained from the curve. For example, the probability of impairment among all sites is approximately 0.25 for sites with TSS less than or equal to 20 mg/L, the median TSS concentration of unimpaired sites. In contrast, Figure 1-2(d) shows the probability of observing an impairment at sites where the stressor level exceeds a specified level of criterion. In this case, the probability of impairment is approximately 0.5 for streams such as the Little Floyd River, O'Brien County where the TSS concentration exceeds 30 mg/L, the median level for impaired sites. The increased slope in the curve that is observable in Figure 1-2(d) is consistent with an increased probability of impairment, and the slope increase occurs in the same range as stressor levels found in the Little Floyd River. The evidence shown in these plots is evidence that TSS levels in the Little Floyd are a plausible stressor associated with increased probability of biological impairment.

(a)



(b)

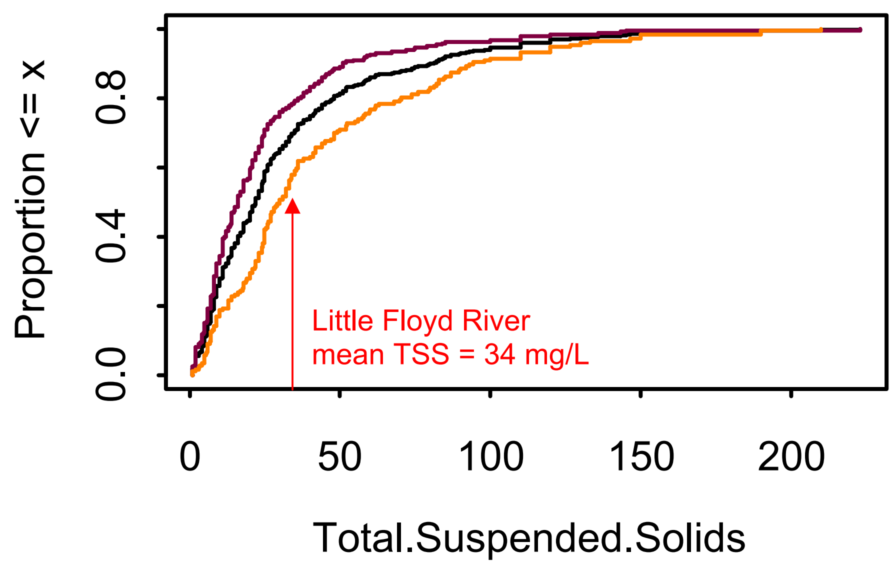


Figure 1-2 Total suspended solids graphs 1

Figure 1-2. Conditional Probability (CP) analysis using example data from the Little Floyd River, O'Brien County; **(a)** Fish Index of Biotic Integrity (FIBI) relationship with Total Suspended Solids (TSS). Data are from the Iowa stream bioassessment database for summer-fall sample index period: 1994-2003. Solid black line represents biological impairment criterion (FIBI=40) for Northwest Iowa Loess Prairies (47a) ecoregion. **(b)** Cumulative Distribution Function (CDF) of TSS for unimpaired sites (FIBI≥40; maroon); impaired sites (FIBI<40; red); all sites (black). Little Floyd River mean TSS (34 mg/L) for 3 sample sites exceeds median value of impaired sites.

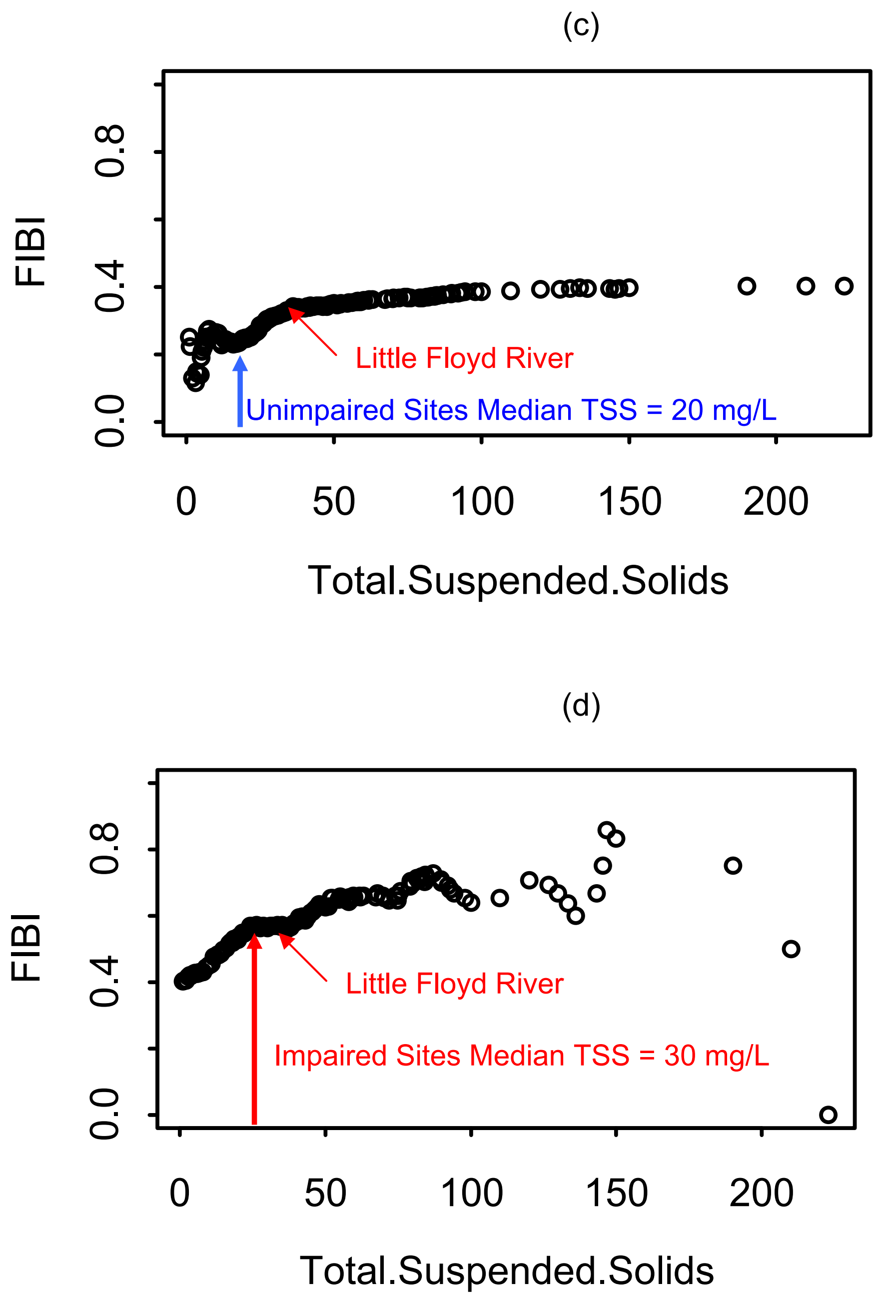


Figure 1-3 Total suspended solids graphs 2

Figure 1-2 (continued). **(c)** Conditional Probability (CP) plot displaying the probability of observing an impairment (i.e., FIBI<40) when the observed stressor level is less than or equal to a specified level or criterion. For example the probability of impairment is approximately 0.25 for sites with TSS less than or equal to 20 mg/L, the median value of unimpaired sites (see Figure 1-2(a)). **(d)** CP plot displaying the probability of observing an impairment (i.e., FIBI<40) when the observed stressor level exceeds a specified level or criterion. For example the probability of impairment is approximately 0.50 for stream sites such as Little Floyd River sites with TSS exceeding 30 mg/L, the median of impaired sites (see Figure 1-2(a)).

E. Rapid Biological Protocol Tolerance Value Calculations

RBP Tolerance Value Development Document

Prepared by:
Iowa Department of Natural Resources
Environmental Services Division
Watershed Monitoring & Assessment
&
Watershed Improvement Sections

The Rapid Bioassessment Protocol (RBP) used by the Iowa Department of Natural Resources (IDNR) is a shortened version of the full bioassessment protocol and allows streams to be biologically assessed efficiently and economically. RBPs are commonly used to do conduct an initial screening of a stream system or are combined with full biological samples to complete a comprehensive survey of multiple tributaries in a single system. The RBP is an important tool used in the watershed assessment process aimed at determining the ecological health of a system. Fish and benthic macroinvertebrate index of biotic integrity scores (FIBI and BMIBI) from stream systems in Iowa are expected to meet criteria developed from IBI scores of local eco-region reference sites. The reference sites are assessed on a five year rotation using the IDNR full bioassessment protocol which allows for the adjustment of FIBI & BMIBI criteria, if applicable. FIBI and BMIBI scores cannot be calculated using the RBP sampling methodology because there is a gap in the level of comparisons that can be made between RBP and full biological sites. In response to this gap and the need for relatively inexpensive and effective biological measurements in the watershed assessment process researchers in the Environmental Services Division developed a method to compare portions of full biological sites to information collected during RBP sampling. The following document contains an outline of the development of RBP tolerance values which were used to compare the average overall tolerance levels of full biological samples to average tolerance values in the RBP samples.

FIBI RBP Tolerance Value Development

Data Conversion

All full fish biological samples in the biocriteria database were converted from actual counts into relative abundance categories and the associated numeric ranges used for RBP sampling (Table 1). Once all full biological samples were converted into RBP classes all fish species in all RBP and full biological samples were assigned a numeric conversion value which corresponded to the mid-point value of the numeric range (Table 1). Since no mid-point could be assigned to the abundant classification, a value was chosen by group consensus that would not over or under estimate the importance of the individual species abundance in the sample.

Table 1-4 RBP relative abundance classes, corresponding numeric range and numeric conversion used for RBP tolerance value calculations

Class	Numeric Range	Numeric Conversion
Rare	1-5	3
Uncommon	6-20	13
Common	21	61
Abundant	> 100	180

Tolerance values for individual fish species were collected from the biocriteria database for use in RBP tolerance value calculations. Tolerance values used ranged from 1-3 with a tolerance gradient from most tolerant (1) to least tolerant (3).

Calculations and Statistics

For data comparison purposes all sites with contributing drainage areas of over 500 mi^2 were eliminated from the calculations. Two exceptions were made for eco-region reference sites: West Fork Cedar River (553 mi^2) and North Skunk River (529 mi^2) due to their inclusion in ecoregion reference criteria calculations. The following calculation was performed on every selected sample from the database to determine the sample's average RBP tolerance value:

1. # individuals from each species * species TOL value
2. ∑ equation 1 for a given sample / ∑ individuals in sample

Once RBP tolerance values were calculated for every selected sample in the database they were separated by site type (reference sites, REMAP sites, and TMDL & watershed test sites). Values from ecoregion reference sites were split into their respective ecoregions and summary statistics were run for each ecoregion (Table 2). The values from theses sites were considered to represent levels from least disturbed aquatic ecosystems. REMAP site samples were split and analyzed identically to the reference sites. Regional Environmental Monitoring and Assessment Program, or REMAP, sites were assessed using the EPA's Environmental Monitoring & Assessment Protocol (EMAP). Sampling under the REMAP program was designed to assess ecosystem health of Iowa's wadeable streams and rivers. RBP tolerance Values from REMAP sites are intended to represent average conditions (neither least disturbed nor impaired) and data from these samples can be found in Table 3. Total Maximum Daily Load (TMDL), watershed, and test samples were split and analyzed the same as the previous two sample types. Values from these sites were used to represent aquatic integrity in degraded or impaired streams. These values represent the most disturbed streams in the biocriteria database and these data can be found in Table 4.

Since many (if not all) RBP sites are located in the upper portion of watersheds, additional summary statistics were run on all the sites with contribution areas of 25 mi^2 or less in each ecoregion. This exercise was completed to determine if the values are different (lower) in smaller stream systems. Data from these smaller drainage areas can be found inTables 5-7.

BMIBI Tolerance Value Development

Data Conversion

Benthic macroinvertebrates are collected during the full biological samples in two ways; semi-quantitatively and qualitatively. For the purpose of this exercise, and to make the data comparable to the RBP data, only the qualitative samples from the full biological samples were used. All benthic invertebrates collected during a full biological sampling are identified to the lowest taxonomic level possible (usually genus or species) to increase the accuracy associated with developing BMIBI values for a given sample. Benthic macroinvertebrates collected during RBP sampling are only identified to the family level. To accommodate for this difference in identification effort, all full biological samples in the biocriteria database had the taxa collected backed out to the family level. Individual families contain many species which may vary considerably in tolerance level. This problem was accounted for by using the average tolerance value score for each family. Tolerance values used ranged from 1 (least tolerant) to 10 (most tolerant). Once the full biological sites were organized to the family level of identification, values for actual numbers of individuals were broken down into numeric classes using the same method described for the FIBI tolerance value calculations (Table 1).

Calculations and Statistics

For data comparison purposes all sites with contributing drainage areas of over 500 mi² were eliminated from the calculations. Two exceptions were made for eco-region reference sites: West Fork Cedar River (553 mi²) and North Skunk River (529 mi²) due to their inclusion in ecoregion reference criteria calculations.

The following calculation was performed on every selected sample from the database to determine the sample's average RBP tolerance value:

3. # individuals from each species * species TOL value
4. ∑ equation 1 for a given sample / ∑ individuals in sample

Once RBP tolerance values were calculated for every selected sample in the database they were separated by site type (reference sites, REMAP sites, and TMDL & watershed test sites). Values from ecoregion reference sites were split into their respective eco-regions and summary statistics were run for each ecoregion (Table 2). The values from theses sites were considered to represent levels from least disturbed aquatic ecosystems. REMAP site samples were split and analyzed identically to the reference sites. Values from REMAP sites are intended to represent average conditions (neither least disturbed nor impaired) and data from these samples can be found in Table 3. Total Maximum Daily Load (TMDL), watershed, and test samples were split and analyzed the same as the previous two sample types. Values from these sites were used to represent aquatic integrity in degraded or impaired streams. These values represent the most disturbed streams in the biocriteria database and these data can be found in Table 4.

Since many (if not all) RBP sites are located in the upper portion of watersheds, additional summary statistics were run on all the sites with contribution areas of 25 mi² or less in each ecoregion. This exercise was completed to determine if the values are different (lower) in smaller stream systems. Data from these smaller drainage areas can be found in Tables 5-7.

Table 1-5 FIBI RBP tolerance values for ecoregion reference sites

Ecoregion	40a	47a	47b	47c	47e	47f	52b	72d	Statewide
N	7	6	20	20	6	19	7	2	87
MEAN	1.49	1.59	1.70	1.94	1.55	1.57	2.12	1.62	1.72
SD	0.18	0.08	0.23	0.23	0.15	0.21	0.20	0.08	0.28
VARIANCE	0.03	0.01	0.05	0.05	0.02	0.04	0.04	0.01	0.08
MINIMUM	1.22	1.51	1.40	1.58	1.30	1.28	1.84	1.57	1.22
25%	1.29	1.51	1.48	1.75	1.47	1.39	1.94	-	1.52
MEDIAN	1.54	1.57	1.68	1.92	1.54	1.57	2.11	1.62	1.68
75%	1.65	1.67	1.91	2.08	1.67	1.76	2.30	-	1.94
MAXIMUM	1.66	1.72	2.19	2.43	1.74	2.00	2.41	1.68	2.43

Table 1-6 FIBI RBP tolerance values for remaps sites by ecoregion

Ecoregion	40a	47a	47b	47c	47d	47e	47f	47m	52b	72d	statewide
N	26	28	27	30	2	24	24	5	14	4	184
MEAN	1.30	1.58	1.62	1.74	1.06	1.38	1.49	1.25	2.13	1.52	1.56
SD	0.27	0.23	0.22	0.20	0.09	0.22	0.32	0.16	0.27	0.03	0.33
VARIANCE	0.07	0.05	0.05	0.04	0.01	0.05	0.10	0.03	0.07	0.00	0.11
MINIMUM	1.00	1.13	1.26	1.31	1.00	1.00	1.01	1.00	1.66	1.48	1.00
1ST	1.11	1.46	1.44	1.58	-	1.25	1.24	1.10	1.94	1.49	1.32
MEDIAN	1.23	1.55	1.63	1.72	1.06	1.36	1.54	1.29	2.10	1.53	1.54
3RD	1.42	1.70	1.77	1.91	-	1.54	1.65	1.39	2.37	1.54	1.75
MAXIMUM	2.00	2.00	2.14	2.13	1.12	1.83	2.35	1.40	2.56	1.54	2.56

Table 1-7 FIBI RBP tolerance values for TMDL & watershed test sites by ecoregion

Ecoregion	40a	47a	47b	47c	47e	47f	52b	72d	statewide
N	8	18	71	36	19	57	13	4	226
MEAN	1.39	1.55	1.59	1.75	1.51	1.49	1.97	1.65	1.59
SD	0.21	0.15	0.21	0.16	0.14	0.32	0.28	0.19	0.26
VARIANCE	0.04	0.02	0.04	0.03	0.02	0.10	0.08	0.03	0.07
MINIMUM	1.17	1.26	1.09	1.47	1.19	1.00	1.69	1.46	1.00
1ST	1.18	1.43	1.45	1.60	1.37	1.27	1.81	1.48	1.42
MEDIAN	1.35	1.57	1.58	1.72	1.57	1.44	1.89	1.65	1.58
3RD	1.62	1.67	1.76	1.90	1.64	1.62	2.09	1.83	1.76
MAXIMUM	1.69	1.81	1.99	2.08	1.67	2.51	2.73	1.84	2.73

Table 1-8 FIBI RBP tolerance values for ecoregion reference sites (<25 mi² drainage area)

Ecoregion	40a	47a	47b	47c	47e	47f	52b	72d	statewide
N	2	2	2	2	4	8	4	5	29
MEAN	1.65	1.66	1.95	1.57	1.41	1.48	1.89	1.61	1.61
SD	0.15	0.03	0.07	0.01	0.21	0.16	0.07	0.20	0.22
VARIANCE	0.02	0.00	0.00	0.00	0.04	0.02	0.00	0.04	0.05
MINIMUM	1.55	1.63	1.91	1.57	1.11	1.29	1.82	1.44	1.11
1ST	-	-	-	-	1.19	1.39	1.83	1.45	1.44
MEDIAN	1.65	1.66	1.95	1.57	1.47	1.43	1.87	1.52	1.58
3RD	-	-	-	-	1.57	1.57	1.96	1.81	1.81
MAXIMUM	1.75	1.68	2.00	1.58	1.60	1.79	1.98	1.89	2.00

Table 1-9 FIBI RBP tolerance values for remap sites by ecoregion (<25 mi² drainage area)

Ecoregion	40a	47a	47b	47c	47d	47e	47f	47m	52b	72d	statewide
N	12	10	11	16	1	7	8	3	9	3	80
MEAN	1.28	1.61	1.51	1.67	1.00	1.24	1.35	1.16	2.07	1.52	1.52
SD	0.31	0.33	0.19	0.22	-	0.22	0.31	0.15	0.27	0.03	0.35
VARIANCE	0.10	0.11	0.04	0.05	-	0.05	0.09	0.02	0.07	0.00	0.13
MINIMUM	1.00	1.13	1.26	1.31	1.00	1.00	1.01	1.00	1.66	1.48	1.00
1ST	1.03	1.23	1.37	1.53	-	1.05	1.06	1.00	1.92	1.48	1.23
MEDIAN	1.20	1.70	1.48	1.59	1.00	1.22	1.28	1.19	2.00	1.53	1.53
3RD	1.34	1.91	1.68	1.87	-	1.45	1.68	1.29	2.28	1.54	1.76
MAXIMUM	2.00	2.00	1.91	2.11	1.00	1.59	1.75	1.29	2.56	1.54	2.56

Table 1-10 FIBI RBP tolerance values for TMDL & watershed test sites by ecoregion (<25 mi² drainage area)

Ecoregion	40a	47a	47b	47c	47f	52b	72d	Statewide
N	5	2	17	17	13	9	4	67
MEAN	1.45	1.56	1.47	1.70	1.52	1.93	1.65	1.61
SD	0.25	0.05	0.16	0.15	0.30	0.31	0.19	0.27
VARIANCE	0.06	0.00	0.03	0.02	0.09	0.10	0.03	0.07
MINIMUM	1.17	1.52	1.19	1.47	1.00	1.69	1.46	1.00
1ST	1.17	-	1.32	1.58	1.32	1.75	1.48	1.46
MEDIAN	1.59	1.56	1.47	1.70	1.46	1.84	1.65	1.59
3RD	1.66	-	1.59	1.84	1.80	1.96	1.83	1.78
MAXIMUM	1.69	1.59	1.75	1.96	2.00	2.73	1.84	2.73

Table 1-11 BMIBI RBP tolerance values for ecoregion reference sites

Ecoregion	40a	47a	47b	47c	47e	47f	52b	72d	Statewide
N	15	11	55	58	12	46	14	6	217
MEAN	5.33	4.98	4.85	4.40	4.99	5.02	4.67	6.16	4.84
SD	0.57	0.44	0.67	0.79	0.61	0.46	0.64	0.60	0.73
VARIANCE	0.33	0.20	0.45	0.62	0.37	0.21	0.41	0.36	0.53
SE MEAN	0.15	0.13	0.09	0.10	0.18	0.07	0.17	0.24	0.05
MINIMUM	4.49	4.31	3.43	1.69	3.75	3.55	3.48	5.57	1.69
1ST QUARTI	4.96	4.68	4.45	4.18	4.68	4.79	4.14	5.57	4.47
MEDIAN	5.15	4.94	4.79	4.55	4.88	5.03	4.80	6.19	4.85
3RD QUARTI	5.78	5.30	5.13	4.83	5.57	5.29	5.12	6.70	5.22
MAXIMUM	6.46	5.65	6.99	5.86	5.95	5.85	5.61	6.75	6.99

Table 1-12 BMIBI RBP tolerance values for remap sites by eco-region

Eco-region	40a	47a	47b	47c	47d	47e	47f	47m	52b	72d	Statewide
N	26	30	29	32	1	27	25	5	14	4	193
MEAN	5.94	5.61	5.31	5.02	6.89	5.35	5.23	5.44	4.87	5.52	5.37
SD	0.71	0.76	0.80	0.67	-	0.51	0.88	1.04	0.80	0.99	0.80
VARIANCE	0.50	0.58	0.63	0.45	-	0.26	0.77	1.07	0.63	0.99	0.64
SE MEAN	0.14	0.14	0.15	0.12	-	0.10	0.18	0.46	0.21	0.50	0.06
MINIMUM	4.63	4.29	3.70	3.47	6.89	3.99	3.11	4.23	3.40	4.26	3.11
1ST QUARTI	5.35	5.14	4.91	4.57	-	5.16	4.74	4.58	4.40	4.50	4.88
MEDIAN	6.09	5.63	5.20	5.01	6.89	5.30	5.30	5.16	4.72	5.68	5.30
3RD QUARTI	6.43	6.03	5.88	5.53	-	5.77	5.68	6.43	5.52	6.38	5.89
MAXIMUM	7.24	7.46	7.28	6.23	6.89	6.22	7.26	6.95	6.22	6.46	7.46

Table 1-13 BMIBI RBP tolerance values for TMDL &watershed test sites by ecoregion

Ecoregion	40a	47a	47b	47c	47e	47f	52b	72d	Statewide
N	14	20	79	62	24	65	32	4	300
MEAN	5.81	5.01	5.27	5.29	5.10	5.15	5.33	6.27	5.26
SD	0.67	0.49	0.88	0.92	0.36	0.86	1.05	0.44	0.86
VARIANCE	0.44	0.24	0.78	0.84	0.13	0.74	1.11	0.19	0.73
SE MEAN	0.18	0.11	0.10	0.12	0.07	0.11	0.19	0.22	0.05
MINIMUM	4.95	4.31	1.60	3.15	4.35	2.19	2.84	5.66	1.60
1ST QUARTI	5.13	4.51	4.85	4.72	4.97	4.77	4.65	5.84	4.82
MEDIAN	5.68	5.06	5.18	5.35	5.10	5.23	5.34	6.37	5.23
3RD QUARTI	6.48	5.47	5.80	5.89	5.29	5.58	6.28	6.61	5.77
MAXIMUM	6.81	5.67	7.37	6.83	6.16	7.51	6.97	6.70	7.51

Table 1-14 BMIBI RBP tolerance values for ecoregion reference sites (<25 mi² drainage area)

Ecoregion	40a	47a	47b	47c	47e	47f	52b	72d	Statewide
N	2	2	2	2	4	8	4	6	113
MEAN	6.04	5.35	5.28	5.55	5.35	5.35	4.90	6.16	5.52
SD	0.49	0.43	0.22	0.43	0.56	0.32	0.30	0.60	1.07
VARIANCE	0.24	0.18	0.05	0.19	0.31	0.10	0.09	0.36	1.15
SE MEAN	0.35	0.30	0.16	0.31	0.28	0.11	0.15	0.24	0.10
MINIMUM	5.70	5.05	5.13	5.25	4.80	5.02	4.67	5.57	2.19
1ST QUART	-	-	-	-	4.84	5.04	4.69	5.57	4.94
MEDIAN	6.04	5.35	5.28	5.55	5.32	5.25	4.80	6.19	5.69
3RD QUART	-	-	-	-	5.89	5.66	5.22	6.70	6.33
MAXIMUM	6.39	5.65	5.44	5.86	5.95	5.84	5.35	6.75	7.51

Table 1-15 BMIBI RBP tolerance values for remap sites by ecoregion (<25 mi² drainage area)

Ecoregion	40a	47a	47b	47c	47d	47e	47f	47m	52b	72d	Statewide
N	11	9	12	16	1	7	8	3	9	3	79
MEAN	6.32	5.48	5.74	5.32	6.89	5.58	5.38	5.93	4.86	5.94	5.58
SD	0.60	0.32	0.77	0.60	-	0.50	1.44	1.01	0.86	0.66	0.85
VARIANCE	0.36	0.10	0.60	0.36	-	0.25	2.08	1.02	0.74	0.43	0.72
SE MEAN	0.18	0.11	0.22	0.15	-	0.19	0.51	0.58	0.29	0.38	0.10
MINIMUM	5.02	5.14	4.36	3.63	6.89	4.99	3.11	4.93	3.40	5.20	3.11
1ST QUARTI	5.93	5.21	5.24	5.03	-	5.16	4.13	4.93	4.08	5.20	5.18
MEDIAN	6.35	5.28	5.72	5.42	6.89	5.39	5.68	5.91	5.14	6.15	5.63
3RD QUARTI	6.63	5.84	6.32	5.64	-	6.10	6.72	6.95	5.61	6.46	6.10
MAXIMUM	7.24	5.89	7.28	6.23	6.89	6.22	7.26	6.95	5.82	6.46	7.28

Table 1-16 BMIBI RBP tolerance values for TMDL & watershed test sites by ecoregion (<25 mi² drainage area)

Ecoregion	40a	47a	47b	47c	47f	52b	72d	Statewide
N	6	2	21	41	17	22	4	113
MEAN	6.47	4.73	5.67	5.36	5.38	5.45	6.27	5.52
SD	0.33	0.27	0.81	1.00	1.49	1.15	0.44	1.07
VARIANCE	0.11	0.07	0.65	1.00	2.22	1.32	0.19	1.15
SE MEAN	0.14	0.19	0.18	0.16	0.36	0.24	0.22	0.10
MINIMUM	5.89	4.54	4.18	3.15	2.19	2.84	5.66	2.19
1ST QUARTI	6.23	-	5.18	4.96	4.43	4.82	5.84	4.94
MEDIAN	6.54	4.73	5.72	5.38	5.77	5.70	6.37	5.69
3RD QUARTI	6.71	-	6.28	6.05	6.56	6.31	6.61	6.33
MAXIMUM	6.81	4.92	7.37	6.83	7.51	6.97	6.70	7.51

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Second Appendix: Data

Water Quality

Table 2-1 2005 Water Quality

							2005						
Site DRC 1	06/09/05	06/16/05	06/23/05	06/30/05	07/07/05	07/14/05	07/21/05	07/28/05	08/04/05	08/11/05	08/18/05	08/25/05	09/01/05
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	960	530	5200	590	500	550	6300	140	380	34000	6600	340	130
Nitrate + Nitrite N (mg/L)	3.8	2.9	2.2	9.7	4.9	2.7	1.8	2.3	1.9	1.2	1	1.8	1.8
Total Kjeldahl N (mg/L)	0.3	0.15	0.16	0.49	0.16	0.05	0.54	0.21	0.1	0.62	0.9	0.1	0.2
Total Phosphate (mg/L)	0.03	<0.02	0.03	0.11	0.04	0.07	0.09	0.04	0.03	0.13	0.28	0.05	0.03
Temp ^{o}C		17.2	20.4	19.5	18.6	20.6	22.1	19.6	19.5			19.3	17
DO (mg/L)		5.45	6.6	5.6	6.5	7.8	4.8	7	9.2			6.6	7.8
pH					8	8							
Chloride (ppm) (test strips)													
Site DRC 2	06/09/05	06/16/05	06/23/05	06/30/05	07/07/05	07/14/05	07/21/05	07/28/05	08/04/05	08/11/05	08/18/05	08/25/05	09/01/05
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	
E.coli (colonies/100mL)	210	210	210	160	150	370	580	140	82	3000	1400	200	
Nitrate + Nitrite N (mg/L)	1.3	0.9	0.95	2.3	1.3	1	1.2	1	1.1	0.087	0.8	0.92	
Total Kjeldahl N (mg/L)	0.05	0.14	0.18	0.3	0.1	0.1	0.19	0.22	0.1	0.34	0.32	0.1	
Total Phosphate (mg/L)	0.03	<0.02	0.03	0.06	0.03	0.06	0.05	0.03	0.03	0.09	0.12	0.04	
Temp ^{o}C		16.6	20.7	17.8	18.1	19.2	20	17.6	18.3			19.5	
DO (mg/L)		5.6	5	5.8	6.9	7.1	6.5	7.3	7.2			7.1	
pH					7.8	7.8							
Site DRC 3	06/09/05	06/16/05	06/23/05	06/30/05	07/07/05	07/14/05	07/21/05	07/28/05	08/04/05	08/11/05	08/18/05	08/25/05	09/01/05
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	1100	200	500	520	540	730	10000	240	120	42000	11000	160	100
Nitrate + Nitrite N (mg/L)	4.8	4.1	3	11	6.5	3.8	2.1	3.2	2.5	1.3	1.2	2.5	2.6
Total Kjeldahl N (mg/L)	0.22	0.24	0.05	0.56	0.38	0.13	0.55	0.24	0.1	0.62	0.98	0.2	0.2
Total Phosphate (mg/L)	0.05	0.02	0.06	0.11	0.04	0.04	0.12	0.04	0.04	0.12	0.32	0.05	0.04
Temp ^{o}C		17.4	22.1	19.5	19.5	21.4	23.2	20	21			19.8	17.9
DO (mg/L)		5.55	5.5	6.5	6.5	7.3	5.6	7.5	9.3			7.8	7.9
pH					7.7	7.8							
Chloride (ppm)													
Site DRC 4	06/09/05	06/16/05	06/23/05	06/30/05	07/07/05	07/14/05	07/21/05	07/28/05	08/04/05	08/11/05	08/18/05	08/25/05	09/01/05
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	370	160	240	300	350	410	910	200	110	3400	3100	240	100
Nitrate + Nitrite N (mg/L)	4.3	3.6	2.8	10	5.5	3.5	2.5	3.1	2.6	2.1	2.2	2.5	2.6
Total Kjeldahl N (mg/L)	0.12	0.34	0.05	0.24	0.1	0.1	0.25	0.12	0.1	0.33	0.1	0.1	0.2
Total Phosphate (mg/L)	0.02	0.01	0.04	0.12	0.05	0.06	0.06	0.05	0.03	0.07	0.08	0.06	0.03
Temp ^{o}C		16.8	20.5	18.4	18.1	20	20.4	20.2	23			20.6	16.3
DO (mg/L)		5.3	4.9	6.3	6	6.5	6	6.6	8.8			5.9	7.5
pH					8.1	7.3							
Chloride (ppm)													

Table 2-1B 2005 Water Quality

				2005				
Site DRC 1	09/08/05	09/15/05	09/22/05	10/05/05	10/20/05	11/02/05	11/21/05	12/28/05
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025		0.025
E.coli (colonies/100mL)	160	530	390	3700	490	110		150
Nitrate + Nitrite N (mg/L)	1.8	1.8	1.9	1.9	1.7	1.9		2.4
Total Kjeldahl N (mg/L)	0.05	0.05	0.05	0.05	0.2	0.05		0.4
Total Phosphate (mg/L)	0.04	0.03	0.03	0.03	0.03	0.04		0.05
Temp ^oC		14.5	17.9	18.6	11.6	13.7		1
DO (mg/L)		7.7	9.3	9.8	9.2	8.5		14
pH								
Chloride (ppm) (test strips)								282
Site DRC 2	09/08/05	09/15/05	09/22/05	10/05/05	10/20/05	11/02/05	11/21/05	12/28/05
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025		
E.coli (colonies/100mL)	220	450	410	170	100	200		
Nitrate + Nitrite N (mg/L)	1	1	1.1	0.97	0.91	0.97		
Total Kjeldahl N (mg/L)	0.05	0.05	0.05	0.05	0.1	0.05		
Total Phosphate (mg/L)	0.04	0.06	0.04	0.03	0.04	0.04		
Temp ^oC		14.7	17.9	18.8	11.9	13.9		
DO (mg/L)		7.9	7.2	9.7	7.1	8.5		
pH								
Site DRC 3	09/08/05	09/15/05	09/22/05	10/05/05	10/20/05	11/02/05	11/21/05	12/28/05
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	130	420	400	320	980	120	580	240
Nitrate + Nitrite N (mg/L)	2.5	2.7	2.4	2.6	2.5	2.8	1.6	2.4
Total Kjeldahl N (mg/L)	0.05	0.05	0.05	0.05	0.2	0.1	0.4	0.3
Total Phosphate (mg/L)	0.04	0.03	0.06	0.05	0.05	0.1	0.03	0.05
Temp ^oC		14.5	18.2	18.8	11.9	13.4	5.6	1
DO (mg/L)		8.2	6.9	10.1	9.7	8.4	12	14
pH								
Chloride (ppm)							135	262
Site DRC 4	09/08/05	09/15/05	09/22/05	10/05/05	10/20/05	11/02/05	11/21/05	12/28/05
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	220	320	200	200	290	91	5	5
Nitrate + Nitrite N (mg/L)	2.6	2.6	2.5	2.6	2.6	3.1	3.3	3.4
Total Kjeldahl N (mg/L)	0.05	0.2	0.05	0.05	0.2	0.05	0.2	0.3
Total Phosphate (mg/L)	0.05	0.05	0.06	0.03	0.04	0.06	0.03	0.06
Temp ^oC		14.6	18	18.6	12.5	13.3	7.8	6
DO (mg/L)		8.5	7.1	9.3	9	8.2	10.3	10
pH								
Chloride (ppm)							64	123

Table 2-1C 2005 Water Quality

	2005												
Site DRC 5	06/09/05	06/16/05	06/23/05	06/30/05	07/07/05	07/14/05	07/21/05	07/28/05	08/04/05	08/11/05	08/18/05	08/25/05	09/01/05
Ammonia N as N (mg/L)	0.025	0.12	0.025	0.025	0.025	0.025	0.11	0.025	0.025	0.07	0.08	0.025	0.025
E.coli (colonies/100mL)	1400	570	4200	630	900	1200	13000	710	1900	21000	21000	110000	6900
Nitrate + Nitrite N (mg/L)	7.4	8.8	7.1	13	11	6.5	2	3.3	2	0.8	0.57	0.92	0.71
Total Kjeldahl N (mg/L)	0.45	0.61	0.9	0.74	0.4	0.22	0.89	0.48	0.34	0.75	1.3	0.4	0.5
Total Phosphate (mg/L)	0.02	0.03	0.05	0.17	0.05	0.09	0.22	0.07	0.03	0.13	0.44	0.1	0.06
Temp °C		17.4	23.3	20.7	19.4	23.1	24.3	18	19.1			22.2	19.4
DO (mg/L)		5.4	5.2	6.6	5.7	6.7	4.7	6.8	8.3			8.1	8.5
pH					8.1	7.5							
Chloride (ppm)													
Site DRC 6	06/09/05	06/16/05	06/23/05	06/30/05	07/07/05	07/14/05	07/21/05	07/28/05	08/04/05	08/11/05	08/18/05	08/25/05	09/01/05
Ammonia N as N (mg/L)	0.05	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	420	330	550	350	510	340	1100	570	210	5100	2600	660	1400
Nitrate + Nitrite N (mg/L)	9.4	8.5	4.9	16	14	10	4	6.5	3.6	0.84	0.96	0.25	0.15
Total Kjeldahl N (mg/L)	0.52	0.62	1	0.38	0.46	0.3	0.59	0.74	1.9	0.71	0.7	1.1	2.2
Total Phosphate (mg/L)	0.07	0.06	0.08	0.13	0.08	0.12	0.08	0.09	0.21	0.1	0.17	0.26	0.46
Temp °C		17.3	22.2	19.5	18.8	21.7	23.4	19.4	22.5	21.6		21.6	18.6
DO (mg/L)		5	4.3	6	5.7	5.6	3.5	6	6	3.4		6.6	5.5
pH					7.9	7.5							
Chloride (ppm)													
Site DRC 7	06/09/05	06/16/05	06/23/05	06/30/05	07/07/05	07/14/05	07/21/05	07/28/05	08/04/05	08/11/05	08/18/05	08/25/05	09/01/05
Ammonia N as N (mg/L)	0.025	0.08	0.025	0.025	0.025	0.025	0.025	0.025			0.025		
E.coli (colonies/100mL)	130	160	310	130	60	30	400	210			2200		
Nitrate + Nitrite N (mg/L)	13	13	13	14	14	14	11	11			5.2		
Total Kjeldahl N (mg/L)	0.38	0.52	0.46	0.23	0.55	0.42	0.39	1.1			0.77		
Total Phosphate (mg/L)	0.01	0.02	0.04	0.11	0.07	0.13	0.05	0.2			0.1		
Temp °C		13.9	17.4	18.1	17.6	17.4	19.4	18.8					
DO (mg/L)		6.23	5.5	5.6	6.4	5.8	4.9	6.9					
pH					8.1	7.3							
Chloride (ppm)													
Site DRC 8	06/09/05	06/16/05	06/23/05	06/30/05	07/07/05	07/14/05	07/21/05	07/28/05	08/04/05	08/11/05	08/18/05	08/25/05	09/01/05
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	0.05	0.025	0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	970	440	8300	450	410	570	3900	2900	560	12000	8100	160	280
Nitrate + Nitrite N (mg/L)	9.6	10	8	14	13	7.3	1.9	3.4	2.2	0.65	0.47	1.2	1.1
Total Kjeldahl N (mg/L)	0.56	0.42	0.48	0.46	0.45	0.35	0.56	0.55	0.42	0.8	0.9	0.4	0.5
Total Phosphate (mg/L)	0.03	0.07	0.06	0.17	0.05	0.06	0.09	0.08	0.04	0.14	0.26	0.06	0.06
Temp °C		17	22.4	19.5	18.7	21.4	24.6	19.8	21.8	19.8		21.1	18.2
DO (mg/L)		5.2	5	6.4	6.7	6	5.1	5.7	6.7	4.5		6.4	6.7
pH					7.5	7.7							
Chloride (ppm)													

Table 2-1D 2005 Water Quality

	2005							
Site DRC 5	09/08/05	09/15/05	09/22/05	10/05/05	10/20/05	11/02/05	11/21/05	12/28/05
Ammonia N as N (mg/L)	0.025	0.025	0.3	0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	160000	12000	260000	2200	25000	23000	1200	400
Nitrate + Nitrite N (mg/L)	0.58	0.41	0.64	0.15	0	0.16	0.78	1.7
Total Kjeldahl N (mg/L)	0.4	0.5	4.6	0.4	0.6	0.9	0.2	0.4
Total Phosphate (mg/L)	0.08	0.05	0.11	0.07	0.24	0.21	0.05	0.04
Temp °C		15.5	20.4	21.1	9	12.1	6.4	1
DO (mg/L)		6.8	5	11	6.7	8.5	9.8	13
pH								
Chloride (ppm)							91	375
Site DRC 6	09/08/05	09/15/05	09/22/05	10/05/05	10/20/05	11/02/05	11/21/05	12/28/05
Ammonia N as N (mg/L)				0.32	2	0.025	0.025	0.025
E.coli (colonies/100mL)				950	60	210	5900	240
Nitrate + Nitrite N (mg/L)				0.025	0.41	0.17	0.56	2.9
Total Kjeldahl N (mg/L)				46	4.5	15	6.2	0.3
Total Phosphate (mg/L)				5.9	1.1	4.2	2	0.05
Temp °C				21	12	12.3	9	4
DO (mg/L)				4.9	7.3	8.4	11	11
pH								
Chloride (ppm) (test strips)							15	64
Site DRC 7	09/08/05	09/15/05	09/22/05	10/05/05	10/20/05	11/02/05	11/21/05	12/28/05
Ammonia N as N (mg/L)						0.025	0.025	0.025
E.coli (colonies/100mL)						5	40	5
Nitrate + Nitrite N (mg/L)						14	9.9	13
Total Kjeldahl N (mg/L)						0.2	0.2	0.05
Total Phosphate (mg/L)						0.06	0.03	0.03
Temp °C						9.2	8.6	6
DO (mg/L)						8.2	11	12
pH								
Chloride (ppm)							15	31
Site DRC 8	09/08/05	09/15/05	09/22/05	10/05/05	10/20/05	11/02/05	11/21/05	12/28/05
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.1	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	410	410	410	230	170	<10	490	200
Nitrate + Nitrite N (mg/L)	0.88	2.7	0.83	0.75	0.75	0.95	1.3	1.6
Total Kjeldahl N (mg/L)	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.5
Total Phosphate (mg/L)	0.06	0.1	0.06	0.1	0.18	0.07	0.14	0.06
Temp °C		15.2	19.8	19.8	12.1	10.1	5.6	1
DO (mg/L)		7.3	6.5	6.5	9	8.2	8.3	15
pH								
Chloride (ppm)							91	375

Table 2-1E 2005 Water Quality

	2005												
Site DRC 9	06/09/05	06/16/05	06/23/05	06/30/05	07/07/05	07/14/05	07/21/05	07/28/05	08/04/05	08/11/05	08/18/05	08/25/05	09/01/05
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	0.05	0.025	0.025	0.025	0.05	0.09	0.025
E.coli (colonies/100mL)	340	450	2100	240	250	780	2500	230	600	2200	2700	260	730
Nitrate + Nitrite N (mg/L)	13	12	11	15	14	11	7.7	7.1	5.3	3.5	1.5	2.7	2.6
Total Kjeldahl N (mg/L)	0.25	0.19	0.09	0.32	0.1	0.24	0.43	0.35	0.42	0.4	1.2	0.4	0.2
Total Phosphate (mg/L)	0.01	0.07	0.09	0.1	0.04	0.07	0.07	0.05	0.07	0.12	0.5	0.07	0.08
Temp °C		14.7	18.6	17.8	16.5	18.6	20	18	20.8	21.1		19.2	15.8
DO (mg/L)		6.6	4.8	5.6	5.5	5.5	5.2	6.8	6.8	5.8		5.7	6.2
pH					7.7	7.1							
Chloride (ppm)													
Site DRC 10	06/09/05	06/16/05	06/23/05	06/30/05	07/07/05	07/14/05	07/21/05	07/28/05	08/04/05	08/11/05	08/18/05	08/25/05	09/01/05
Ammonia N as N (mg/L)	0.05	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	950	530	1200	490	580	520	3600	230	270	29000	6800	110	270
Nitrate + Nitrite N (mg/L)	13	13	11	16	16	11	1.5	5.6	2.2	0.59	0.51	0.63	0.16
Total Kjeldahl N (mg/L)	0.37	0.29	0.31	0.7	0.1	0.17	0.66	0.61	0.34	0.53	0.79	0.2	0.4
Total Phosphate (mg/L)	0.04	0.06	0.07	0.15	0.05	0.08	0.09	0.08	0.04	0.07	0.16	0.07	0.06
Temp °C		16.4	20.8	19.8	17.4	20.4	23.5	18.2	21.3			20.5	17
DO (mg/L)		6	5.2	6.7	6.5	5.6	4.2	6.2	5			7	5.5
pH					8	7.7							
Chloride (ppm)													

Table 2-1F 2005 Water Quality

	2005							
Site DRC 9	09/08/05	09/15/05	09/22/05	10/05/05	10/20/05	11/02/05	11/21/05	12/28/05
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.07	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	600	800	220	200	180	210	310	130
Nitrate + Nitrite N (mg/L)	2.4	1	3	3.5	4.1	5.1	5	5.1
Total Kjeldahl N (mg/L)	0.4	0.2	0.4	0.2	0.2	0.3	0.3	0.3
Total Phosphate (mg/L)	0.09	0.07	0.13	0.12	0.07	0.07	0.04	0.06
Temp °C		13.5	19.2	19.2	8.8	6.3	3.5	1
DO (mg/L)		7.5	6.5	6.5	9.3	8.2	9.6	14
pH								
Chloride (ppm)							15	15
Site DRC 10	09/08/05	09/15/05	09/22/05	10/05/05	10/20/05	11/02/05	11/21/05	12/28/05
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.06	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	160	240	460	390	630	5	91	260
Nitrate + Nitrite N (mg/L)	0.05	0.09	0.12	0.13	0.19	0.47	1.1	1.8
Total Kjeldahl N (mg/L)	0.3	0.3	0.2	0.3	0.2	0.2	0.3	0.6
Total Phosphate (mg/L)	0.06	0.05	0.07	0.07	0.17	0.06	0.06	0.07
Temp °C		14.8	20.3	20.3	10.5	8.1	5.6	2
DO (mg/L)		6.5	6.4	6.4	7.7	8	10.5	12
pH								
Chloride (ppm)							64	375

Table 2-2 2006 Water Quality

Site DRC 1	03/09/06	04/12/06	04/26/06	05/02/06	05/24/06	06/08/06	06/15/06	06/20/06	07/05/06	07/18/06	08/01/06
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.050	0.025	0.025	0.025
E.coli (colonies/100mL)	220	73	82	270	220	360	880	6900	630	1400	710
Nitrate + Nitrite N (mg/L)	3.4	4.2	5.5	13.0	4.9	4.1	4.8	3.6	2.8	2.3	2.2
Total Kjeldahl N (mg/L)	0.8	0.4	0.2	0.6	0.1	0.1	0.3	0.6	0.1	0.1	0.2
Total Phosphate (mg/L)	0.10	0.03	0.02	0.10	0.03	0.03	0.04	0.10	0.04	0.06	0.03
Ortho-phosphate (mg/L)		0.01	0.01	0.06	0.01	0.02	0.02	0.03	0.03	0.02	0.01
TSS (mg/L)		5	5	17	5	6	6	58	6	5	4
TDS (mg/L)									330	310	340
Temp ^{o}C	6	15.7	13	12.3	21.9	20.1	18.2	18.5	16	17.8	19.8
DO (mg/L)	11.6	9.5	9.6	9.2	6.8	6.7	6.8	6.4	10.1	9.3	9.1
pH	7.9	8.2	8.4	8.4	8.2	8.3	8.2	8.2	8.3	8.3	8.4
Turbidity (NTU)	40	4.7	2.3	8.4	3.2	3	3.8	34.7	4	1.4	2
Transp. (mm)	190	>600	>600		>600	>600	>600		>600	>600	
Chloride (ppm)	208	34		46	33	33	33		24	23	24
flow rate (CFS)									28		26

Site DRC 2	03/09/06	04/12/06	04/26/06	05/02/06	05/24/06	06/08/06	06/15/06	06/20/06	07/05/06	07/18/06	08/01/06
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.120	0.025	0.025	0.025
E.coli (colonies/100mL)	280	40	240	60	300	480	260	4000	370	380	160
Nitrate + Nitrite N (mg/L)	3.0	1.0	1.3	3.4	1.4	1.5	1.3	1.1	1.3	1.4	1.4
Total Kjeldahl N (mg/L)	1.0	0.2	0.2	0.3	0.1	0.1	0.1	0.6	0.1	0.1	0.1
Total Phosphate (mg/L)	0.14	0.02	0.01	0.05	0.03	0.03	0.02	0.10	0.02	0.02	0.02
Ortho-phosphate (mg/L)		0.01	0.01	0.02	0.01	0.01	0.07	0.02	0.01	0.01	0.01
TSS (mg/L)		1	2	6	6	3	3	39	2	3	3
Temp ^{o}C	5	16.2	14.8	14.9	21.1	20.1	18.6	17.6	19.4	19.5	21.2
DO (mg/L)	10.9	8.8	7.9	8.1	6.1	6.3	6.1	5.8	6.6	6	6.1
pH	7.8	8.3	8.3	8.4	8.3	8.3	8.4	8.3	8.3	8.4	8.3
Turbidity (NTU)	35.8	1.3	0.8	5.8	3.5	1.9	1.4	19.3	2.4	2.5	3
Transp. (mm)	240	>600			>600	>600	>600	350	>600	>600	>600
Chloride (ppm)	135	27		33	33	33	33		27	29	27

Table 2-2B 2006 Water Quality

Site DRC 1	8/15/2006	8/29/2006	9/12/2006	9/26/2006	10/10/2006	10/24/2006	11/7/2006	12/5/2006
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.090	0.025	0.025
E.coli (colonies/100mL)	2200	730	990	440	900	240	200	130
Nitrate + Nitrite N (mg/L)	2	1.8	7.6	4.7	3.1	5.3	10	12
Total Kjeldahl N (mg/L)	0.2	0.05	0.5	0.1	0.1	0.6	0.2	0.3
Total Phosphate (mg/L)	0.03	0.03	0.16	0.01	0.03	0.14	0.03	0.03
Ortho-phosphate (mg/L)	0.01	0.01	0.11	0.01	0.01	0.1	0.01	0.02
TSS (mg/L)	2	3	37	2	0.5	2	1	2
TDS (mg/L)	320	280	340		300	350	330	350
Temp ^{o}C	18.8	16.8	15.2	12.5	12.7	7.8	9.6	0
DO (mg/L)	13.3	9.4	9.3	10.4	10.2	12.6	14.1	13.8
pH	8.3	8.4	8.3	7.7	7.9	8	8.1	7.9
Turbidity (NTU)	1.1	<1	24	0.5	1.1	2.4	1.1	1.8
Transp. (mm)								600
Chloride (ppm)	24	24	32	30	27	33	46	43
flow rate (CFS)	26	26	104	25	24	12	6	

Site DRC 2	8/15/2006	8/29/2006	9/12/2006	9/26/2006	10/10/2006	10/24/2006	11/7/2006	12/5/2006
Ammonia N as N (mg/L)	0.025		0.025	0.025	0.025	0.150	0.025	0.025
E.coli (colonies/100mL)	91		510	40	140	120	10	310
Nitrate + Nitrite N (mg/L)	1.4		1.8	1.7	1.4	7	3.7	5.6
Total Kjeldahl N (mg/L)	0.1		0.1	0.05	0.05	0.9	0.2	0.4
Total Phosphate (mg/L)	0.03		0.06	0.02	0.04	0.18	0.07	0.04
Ortho-phosphate (mg/L)	0.01		0.05	0.01	0.01	0.14	0.01	0.03
TSS (mg/L)	2		8	1	1	3	18	1
Temp ^{o}C	18.8		16.1	13.5	13.4	7.9	11.8	0.1
DO (mg/L)	9		8.9	9.9	9.6	13.2	11.4	15.5
pH	8.4			7.9	7.9	7.8	8.2	7.7
Turbidity (NTU)	1.7		7.69	1.61	1.34	2.54	1.29	3
Transp. (mm)	>600		600	600	600	600	600	600
Chloride (ppm)	27		27	33	33	39	36	53

Table 2-2C 2006 Water Quality

Site DRC 3	03/09/06	04/12/06	04/26/06	05/02/06	05/24/06	06/08/06	06/15/06	06/20/06	07/05/06	07/18/06	08/01/06
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.250	0.025	0.025	0.025
E.coli (colonies/100mL)	380	150	50	290	170	450	1200	25000	450	820	1500
Nitrate + Nitrite N (mg/L)	3.6	5.1	6.8	14.0	6.0	5.2	5.9	3.0	3.6	2.9	2.8
Total Kjeldahl N (mg/L)	0.9	0.5	0.2	0.6	0.2	0.1	0.4	1.0	0.2	0.1	0.1
Total Phosphate (mg/L)	0.12	0.04	0.03	0.11	0.04	0.05	0.04	0.15	0.04	0.03	0.04
Ortho-phosphate (mg/L)		0.01	0.01	0.06	0.01	0.02	0.02	0.03	0.02	0.02	0.02
TSS (mg/L)		5	2	23	9	5	7	63	9	5	4
Temp °C	5.2	16.9	12.5	12.4	21.8	18.8	18.2	17.7	20	22.3	21.1
DO (mg/L)	11.4	8.4	9.6	7.5	6.5	6.8	6.8	5.7	7.3	6.3	6.5
pH	8	8.3	8.3	8.1	8.2	8.4	8.2	8.2	8.2	8.3	8.1
Turbidity (NTU)	55.2	4.3	1.7	21.9	5.4	3.3	7.7	55.7	5.2	5.5	3
Transp. (mm)	140	>600	>600		>600	>600	>600	120	>600	>600	>600
Chloride (ppm)	225	48		46	33	33	33		34	27	27

Site DRC 4	03/09/06	04/12/06	04/26/06	05/02/06	05/24/06	06/08/06	06/15/06	06/20/06	07/05/06	07/18/06	08/01/06
Ammonia N as N (mg/L)	0.060	0.100	0.025	0.025	0.025	0.025	0.025	0.120	0.025	0.025	0.025
E.coli (colonies/100mL)	460	290	20	210	220	50	490	4200	150	310	190
Nitrate + Nitrite N (mg/L)	4.8	4.6	5.4	12.0	4.4	4.0	3.9	2.6	3.0	2.7	2.5
Total Kjeldahl N (mg/L)	0.7	0.6	0.1	0.5	0.3	0.1	0.2	0.6	0.1	0.05	0.2
Total Phosphate (mg/L)	0.10	0.05	0.03	0.08	0.03	0.04	0.04	0.13	0.03	0.06	0.03
Ortho-phosphate (mg/L)		0.01	0.01	0.04	0.01	0.02	0.01	0.03	0.03	0.02	0.02
TSS (mg/L)		6	1	12	4	9	6	76	4	2	3
TDS (mg/L)									350	350	360
Temp °C	5.3	15.1	11.5	13.3	19.8	17.6	17.6	17.3	16	17.8	19.2
DO (mg/L)	10.6	8.5	8.9	8	5.7	6.7	6.1	6.6	9.2	8.5	7.9
pH	7.7	8.1	8.4	8.1	8	8.1	8.1	8.2	8.2	8	8
Turbidity (NTU)	28	2.8	1.2	11.9	2.7	4.5	3.3	118	3.8	3.8	2*
Transp. (mm)	200	>600	>600		>600	>600	>600	88		>600	
Chloride (ppm)	112	27		39	39	33	33	<33	29*	33	30*
flow rate (CFS)									20		17

Table 2-2C 2006 Water Quality

Site DRC 3	8/15/2006	8/29/2006	9/12/2006	9/26/2006	10/10/2006	10/24/2006	11/7/2006	12/5/2006
Ammonia N as N (mg/L)	0.025		0.025	0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	510		1000	280	390	400	73	240
Nitrate + Nitrite N (mg/L)	2.4		8.7	5.8	4.1	0.08	9.7	13
Total Kjeldahl N (mg/L)	0.2		0.3	0.05	0.2	0.1	0.1	0.3
Total Phosphate (mg/L)	0.04		0.16	0.03	0.03	0.01	0.05	0.03
Ortho-phosphate (mg/L)	0.01		0.11	0.02	0.01	0.01	0.01	0.02
TSS (mg/L)	1		29	2	0.5	1	2	3
Temp ^{o}C	18.3		15.3	12.9	12.5	11.3	10.6	0.1
DO (mg/L)	9.6		8.8	9.8	10.7	10.8	14.6	14.8
pH	8.1			8	7.9	7.9	8.2	7.9
Turbidity (NTU)	1.3		23.6	2.01	0.88	1.35	1.76	3
Transp. (mm)	>600		292	600	600	600	600	600
Chloride (ppm)	27		48	39		<33	46	43

Site DRC 4	8/15/2006	8/29/2006	9/12/2006	9/26/2006	10/10/2006	10/24/2006	11/7/2006	12/5/2006
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.330	0.025	0.025
E.coli (colonies/100mL)	100	100	530	160	60	740	290	190
Nitrate + Nitrite N (mg/L)	2.3	2.3	7.8	4.6	3.4	5.5	9.6	13
Total Kjeldahl N (mg/L)	0.2	0.05	0.2	0.2	0.1	1.4	0.2	0.2
Total Phosphate (mg/L)	0.02	0.04	0.1	0.04	0.03	0.3	0.04	0.03
Ortho-phosphate (mg/L)	0.02	0.02	0.08	0.04	0.01	0.23	0.01	0.03
TSS (mg/L)	20	2	20	3	1	7	1	5
TDS (mg/L)	340	330	360		310	370	340	330
Temp ^{o}C	17.6	17.2	15.1	13.9	13.4	8.1	9.6	0.7
DO (mg/L)	11.8	8.1	8.8	8.5	8.8	10.8	10.4	13.5
pH	8	8.1	7.9	7.9	7.7	7.7	8	8
Turbidity (NTU)	<1	<1	14	1.5	1.3	3.5	1.3	2.5
Transp. (mm)								600
Chloride (ppm)	30	31	31	33	33	36	38	37
flow rate (CFS)	15	17	41	16	13	6	2	6

Table 2-2D 2006 Water Quality

Site DRC 5	03/09/06	04/12/06	04/26/06	05/02/06	05/24/06	06/08/06	06/15/06	06/20/06	07/05/06	07/18/06	08/01/06
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.240	0.025	0.025	0.025
E.coli (colonies/100mL)	200	270	100	140	560	2200	2500	25000	3200	10000	7400
Nitrate + Nitrite N (mg/L)	3.2	7.2	14.0	18.0	14.0	14.0	15.0	4.8	9.2	5.4	5.6
Total Kjeldahl N (mg/L)	0.8	0.6	0.3	0.7	0.6	0.4	0.4	1.5	0.3	0.5	0.4
Total Phosphate (mg/L)	0.09	0.03	0.03	0.14	0.03	0.05	0.07	0.27	0.07	0.06	0.05
Ortho-phosphate (mg/L)		0.01	0.01	0.07	0.01	0.02	0.04	0.03	0.03	0.03	0.03
TSS (mg/L)		4	3	28	3	2	9	110	3	7	2
Temp ^{o}C	4.6	15.9	10	11.7	21.8	20.3	18.1	18.1	21.1	22.1	24.4
DO (mg/L)	11.8	10.3	10.5	6.7	5.9	6.2	6.1	6.3	6.5	5.4	5.1
pH	7.9	8.4	8.6	8.2	8.3	8.3	8.3	8.4	8.3	8.6	8.2
Turbidity (NTU)	24.3	5	3.6	22.1	3.4	2.3	6.5	66.1	4.9	9.2	3
Transp. (mm)	250	>600	>600		>600	>600	>600	140	>600	>600	>600
Chloride (ppm)	303	82		53	61	53	46		48	48	56

Site DRC 6	03/09/06	04/12/06	04/26/06	05/02/06	05/24/06	06/08/06	06/15/06	06/20/06	07/05/06	07/18/06	08/01/06
Ammonia N as N (mg/L)	0.080	0.840	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	1000	910	30	82	40	520	830	2800	180	82	150
Nitrate + Nitrite N (mg/L)	5.5	9.2	14.0	18.0	14.0	13.0	11.0	7.6	8.2	5.4	6.3
Total Kjeldahl N (mg/L)	1.2	1.9	0.6	0.9	0.4	0.6	0.5	0.9	0.4	0.5	0.5
Total Phosphate (mg/L)	0.15	0.16	0.04	0.08	0.05	0.10	0.08	0.12	0.06	0.06	0.07
Ortho-phosphate (mg/L)		0.07	0.01	0.05	0.01	0.03	0.03	0.02	0.04	0.04	0.04
TSS (mg/L)		13	11	10	12	36	19	44	7	6	6
TDS (mg/L)									410	390	400
Temp ^{o}C	5	13.8	10	12.3	20	20.6	18.2	18.9	19.5	23.3	24.2
DO (mg/L)	9.8	9.1	9	7.9	5.6	5.5	5.8	6.1	7.4	6.3	6.5
pH	7.7	8.1	8.4	8	8	8.1	8.2	8.1	8	8	7.7
Turbidity (NTU)	51.6	9.3	2.2	5.89	6.2	20.3	12.3	37.4	5.5	5.5	5*
Transp. (mm)	140	350	>600		>600	380	425		>600	>600	
Chloride (ppm) (test strips)	81	41		39	46	39	39		35	35	31

Table 2-2E 2006 Water Quality

Site DRC 5	8/15/2006	8/29/2006	9/12/2006	9/26/2006	10/10/2006	10/24/2006	11/7/2006	12/5/2006
Ammonia N as N (mg/L)	0.025		0.025	0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	2000		1900	290	3500	55	110	180
Nitrate + Nitrite N (mg/L)	4.9		9.7	10	8.6	11	11	13
Total Kjeldahl N (mg/L)	0.7		0.4	0.5	0.4	0.3	0.3	0.3
Total Phosphate (mg/L)	0.04		0.2	0.03	0.03	0.03	0.06	0.02
Ortho-phosphate (mg/L)	0.02		0.14	0.02	0.01	0.02	0.01	0.02
TSS (mg/L)	1		37	1	0.5	2	2	1
Temp °C	20.8		15.6	12.5	11.5	5.8	10.5	0.7
DO (mg/L)	6.9		8.7	10.6	10.5	13.5	14.4	14.5
pH	8.2			7.9	8.1	7.9	8.2	7.8
Turbidity (NTU)	2.1		26.7	1.93	1.22	1.19	2.2	2
Transp. (mm)	>600		281	600	600	600	600	600
Chloride (ppm)	64		56	46	61	53	53	53

Site DRC 6	8/15/2006	8/29/2006	9/12/2006	9/26/2006	10/10/2006	10/24/2006	11/7/2006	12/5/2006
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	1.700	0.025	0.025
E.coli (colonies/100mL)	30	380	680	310	190	4900	120	91
Nitrate + Nitrite N (mg/L)	2.2	0.23	12	10	8.5	5.9	11	15
Total Kjeldahl N (mg/L)	0.4	0.2	0.3	0.3	0.3	4.2	0.3	0.3
Total Phosphate (mg/L)	0.07	0.08	0.12	0.04	0.04	1.2	0.05	0.04
Ortho-phosphate (mg/L)	0.03	0.04	0.09	0.03	0.01	0.89	0.02	0.03
TSS (mg/L)	8	3	21	5	3	20	4	3
TDS (mg/L)	400	340	400		370	400	340	350
Temp °C	21.6	20.9	15.7	12.8	11.5	4.5	9.7	1.4
DO (mg/L)	9.5	5.6	8.3	9	8.8	11.7	10.7	13.2
pH	8.4	8.2		7.7	7.7	7.6	7.9	7.7
Turbidity (NTU)	3.3	1.2	15	3	2.3	11	2.1	2.3
Transp. (mm)								600
Chloride (ppm) (test strips)	30	28	33	34	32	41	34	33

Table 2-2F 2006 Water Quality

Site DRC 7	03/09/06	04/12/06	04/26/06	05/02/06	05/24/06	06/08/06	06/15/06	06/20/06	07/05/06	07/18/06	08/01/06
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	10	5	5	50	10	10	5	270	280	45	120
Nitrate + Nitrite N (mg/L)	13.0	17.0	18.0	23.0	20.0	22.0	19.0	19.0	19.0	18	17
Total Kjeldahl N (mg/L)	0.2	0.2	0.2	0.6	0.2	0.1	0.2	0.2	0.1	0.1	0.2
Total Phosphate (mg/L)	0.04	0.01	0.02	0.11	0.02	0.03	0.02	0.02	0.04	0.03	0.04
Ortho-phosphate (mg/L)		0.01	0.01	0.09	0.01	0.01	0.01	0.02	0.01	0.01	0.01
TSS (mg/L)		3	2	1	1	14	1	5	1	1	10
Temp ^{o}C	4.5	9	9.1	13.4	14.8	15.5	15.3	15.4	16.6	18.4	18.5
DO (mg/L)	10.2	10.2	8.6	7.3	7.2	6.8	6.5	6.4	6.1	6.2	4.9
pH	7.5	8.1	8.2	7.6	7.9	7.5	7.9	7.7	7.7	7.1	7.5
Turbidity (NTU)	1.6	1.1	0.8	1.96	0.7	2.7	0.7	9.7	2	3.2	7
Transp. (mm)	600	600	600		600	600	600	600		600	600
Chloride (ppm)	<31	27		33	33	33	33	33	27	27	<27

Site DRC 8	03/09/06	04/12/06	04/26/06	05/02/06	05/24/06	06/08/06	06/15/06	06/20/06	07/05/06	07/18/06	08/01/06
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	40	5	55	55	100	520	780	11000	830	720	390
Nitrate + Nitrite N (mg/L)	3.4	9.4	15.0	19.0	16.0	16.0	17.0	5.4	9.8	7.6	5
Total Kjeldahl N (mg/L)	0.8	0.6	0.4	0.7	0.4	0.3	0.3	0.8	0.4	0.4	0.4
Total Phosphate (mg/L)	0.07	0.04	0.03	0.12	0.04	0.04	0.06	0.10	0.06	0.04	0.05
Ortho-phosphate (mg/L)		0.01	0.01	0.06	0.01	0.01	0.07	0.01	0.03	0.03	0.03
TSS (mg/L)		5	2	19	3	4	2	36	3	2	4
Temp ^{o}C	6.1	16.4	11.9	14	21.4	21.2	18	18.9	22.4	23.5	23.7
DO (mg/L)	11.1	9.2	10.5	7.8	6.8	6.7	6.8	5.8	7	6	5.4
pH	7.9	8.3	8.4	8	8.1	8.2	8.2	8.2	8.2	8.2	8.2
Turbidity (NTU)	11.2	5.8	2.1	18.2	2.6	2.2	2.7	39.1	3.3	4	3
Transp. (mm)	>600	>600	>600		>600	>600	>600		>600	>600	>600
Chloride (ppm)	303	73		53	53	46	46		48	48	56

Table 2-2G 2006 Water Quality

Site DRC 7	8/15/2006	8/29/2006	9/12/2006	9/26/2006	10/10/2006	10/24/2006	11/7/2006	12/5/2006
Ammonia N as N (mg/L)	0.025		0.025	0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	460		740	55	10	10	5	5
Nitrate + Nitrite N (mg/L)	17		15	15	15	14	14	18
Total Kjeldahl N (mg/L)	0.2		0.3	0.2	0.1	0.1	0.05	0.2
Total Phosphate (mg/L)	0.03		0.21	0.01	0.04	0.01	0.02	0.01
Ortho-phosphate (mg/L)	0.01		0.21	0.01	0.01	0.01	0.01	0.02
TSS (mg/L)	6		6	0.5	4	3	1	2
Temp ^{o}C	17.6		16.6	15.1	14.3	12	10.2	8.1
DO (mg/L)	7.2		7.5	7.6	7.9	8	9.3	9.6
pH	7.4			7.5	7.5	8.1	7.9	7.4
Turbidity (NTU)	3		4.29	0.93	1.2	1.35	0.61	1
Transp. (mm)	600		600	600	600	600	600	600
Chloride (ppm)	27		34	<33	33	<33	<33	<33

Site DRC 8	8/15/2006	8/29/2006	9/12/2006	9/26/2006	10/10/2006	10/24/2006	11/7/2006	12/5/2006
Ammonia N as N (mg/L)	0.025		0.025	0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	450		650	140	30	27	20	60
Nitrate + Nitrite N (mg/L)	5.3		10	11	9.5	11	12	14
Total Kjeldahl N (mg/L)	0.6		0.4	0.2	0.3	0.3	0.3	0.3
Total Phosphate (mg/L)	0.05		0.17	0.02	0.02	0.03	0.02	0.03
Ortho-phosphate (mg/L)	0.02		0.12	0.02	0.01	0.01	0.01	0.02
TSS (mg/L)	2		29	1	1	2	2	1
Temp ^{o}C	18.7		15.9	13.5	11	6.5	10.7	2.9
DO (mg/L)	7.5		8.3	9.9	9	13	14.1	13
pH	8.2			7.9	8.3	7.9	8.2	7.9
Turbidity (NTU)	2.3		18.1	2.99	1.4	1.33	1.96	2
Transp. (mm)	>600		379	600	600	600	600	600
Chloride (ppm)	56		56	53	46	53	46	46

Table 2-2H 2006 Water Quality

Site DRC 9	03/09/06	04/12/06	04/26/06	05/02/06	05/24/06	06/08/06	06/15/06	06/20/06	07/05/06	07/18/06	08/01/06
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	20	50	30	370	60	540	940	2900	480	900	1600
Nitrate + Nitrite N (mg/L)	6.3	9.9	13.0	18.0	14.0	15.0	15.0	33.0	13.0	9.9	8.2
Total Kjeldahl N (mg/L)	0.6	0.4	0.4	0.4	0.3	0.7	0.3	0.5	0.3	0.3	0.2
Total Phosphate (mg/L)	0.09	0.03	0.02	0.07	0.03	0.13	0.06	0.07	0.05	0.06	0.06
Ortho-phosphate (mg/L)		0.01	0.01	0.04	0.01	0.02	0.09	0.01	0.03	0.04	0.04
TSS (mg/L)		5	13	20	13	10	14	33	11	16	12
Temp ^{o}C	4.7	11.7	8.2	13.6	17.8	15.4	15.7	14.5	15.4	20.7	19.9
DO (mg/L)	10.6	11	10	7.4	7.3	7	6.7	6.2	6.4	6.3	5.6
pH	7.9	8.2	8.4	7.7	8.1	8.1	8.2	8.2	8.4	7.9	8.1
Turbidity (NTU)	7.2	6.1	1.9	10.7	5.5	4.9	7.6	16.2	5.4	7.1	6
Transp. (mm)	>600	>600	>600		>600	>600	>600	395		>600	>600
Chloride (ppm)	81	48		39	39	33	39	33	34	34	27

Site DRC 10	03/09/06	04/12/06	04/26/06	05/02/06	05/24/06	06/08/06	06/15/06	06/20/06	07/05/06	07/18/06	08/01/06
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	27	30	130	91	140	550	780	3000	530	440	500
Nitrate + Nitrite N (mg/L)	4.6	15.0	19	22.0	18.0	18.0	19.0	18.0	15.0	11	7.8
Total Kjeldahl N (mg/L)	0.8	0.4	0.4	0.6	0.4	0.5	0.3	0.3	0.4	0.3	0.3
Total Phosphate (mg/L)	0.09	0.03	0.03	0.11	0.02	0.05	0.07	0.05	0.05	0.1	0.06
Ortho-phosphate (mg/L)		0.01	0.01	0.07	0.01	0.02	0.02	0.01	0.03	0.03	0.03
TSS (mg/L)		2	2	13	2	6	5	9	4	4	10
Temp ^{o}C	4.4	12.3	8	13.5	16.5	16.7	16.4	15.6	16.7	23.4	22.5
DO (mg/L)	11.3	12.1	10.4	7.6	6.3	6.2	6.1	6.5	6.5	6.6	5.2
pH	8.6	8.2	8.4	7.7	8.4	8.5	8.4	8.6	8.5	8.2	8.2
Turbidity (NTU)	10.1	3.1	2	8.84	2.7	3.2	4.1	4.8	4.1	10.5	4
Transp. (mm)	>600	>600	>600		>600	>600	>600	>600		>600	>600
Chloride (ppm)	375	73		46	46	46	39	39	48	48	48

Table 2-2I 2006 Water Quality

Site DRC 9	8/15/2006	8/29/2006	9/12/2006	9/26/2006	10/10/2006	10/24/2006	11/7/2006	12/5/2006
Ammonia N as N (mg/L)	0.025		0.025	0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	560		290	230	740	150	360	27
Nitrate + Nitrite N (mg/L)	6		11	9.8	9.2	10	11	14
Total Kjeldahl N (mg/L)	0.4		0.2	0.2	0.2	0.3	0.05	0.3
Total Phosphate (mg/L)	0.06		0.11	0.02	0.03	0.03	0.05	0.03
Ortho-phosphate (mg/L)	0.04		0.07	0.02	0.03	0.02	0.01	0.03
TSS (mg/L)	5		38	3	3	3	3	8
Temp ^oC	16.9		16.2	14.4	11.7	6.9	9.9	4.4
DO (mg/L)	7.3		7.8	9	9	10.8	10.8	11.4
pH	8.3			7.7	7.9	8.4	7.9	7.7
Turbidity (NTU)	4.1		20.1	2.55	2.44	2.95	1.76	5
Transp. (mm)	>600		400	600	600	600	600	600
Chloride (ppm)	27		48	39	39	33	33	39

Site DRC 10	8/15/2006	8/29/2006	9/12/2006	9/26/2006	10/10/2006	10/24/2006	11/7/2006	12/5/2006
Ammonia N as N (mg/L)	0.025		0.025	0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	380		480	73	110	220	82	130
Nitrate + Nitrite N (mg/L)	7.7		13	13	13	13	14	16
Total Kjeldahl N (mg/L)	0.5		0.4	0.2	0.3	0.3	0.3	0.2
Total Phosphate (mg/L)	0.06		0.17	0.05	0.03	0.03	0.02	0.03
Ortho-phosphate (mg/L)	0.03		0.14	0.02	0.01	0.02	0.01	0.02
TSS (mg/L)	7		17	2	9	2	2	3
Temp ^oC	18.1		16	14	11.1	5.7	9.5	2.2
DO (mg/L)	7		7.9	10.6	9.6	11.5	10.9	12.8
pH	8.4			7.9	8.1	8.6	8.4	8.2
Turbidity (NTU)	4.2		12.6	1.74	3.67	1.58	1.64	2
Transp. (mm)	>600		472	600	600	600	600	600
Chloride (ppm)	48		56	46	46	39	46	46

Table 2-3 2007 Water Quality

Site DRC 1	1/11/2007	2/15/2007	3/6/2007	3/20/2007	4/3/2007	4/17/2007	5/1/2007	5/15/2007	5/30/2007	6/13/2007	6/27/2007
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025		0.025	0.025
E.coli (colonies/100mL)	130	50	5	310	2800	20	73	210		490	710
Nitrate + Nitrite N (mg/L)	12	8.8	7.5	8.9	6	7.3	7.9	5.5		5.6	5.1
Total Kjeldahl N (mg/L)	0.2	0.3	0.3	0.4	2.2	0.4	0.1	0.05		0.2	0.2
Total Phosphate (mg/L)	0.02	0.01	0.07	0.04	0.65	0.04	0.06	0.04		0.04	0.05
Ortho-phosphate (mg/L)	0.01	0.01	0.03	0.03	0.2	0.02	0.02	0.01		0.01	0.02
TSS (mg/L)	2	0.5	5	5	270	3	7	4		6	15
TDS (mg/L)		400	430	390	290	330	340	330		340	340
Temp ^{o}C	1.8	0.3	0.0	3.9	11.2	10.7	14.7	14.8		18.1	19.6
DO (mg/L)	16.3	14.3	15.7	12.0	11.2	12.8	10.5	9.7		9.3	9.4
pH	8.4	8.2	8.2	8.3	7.8	8	7.7	8		8	8
Turbidity (NTU)	2.4				230	1.7	2.9	1.1		2.1	5.8
Transp. (mm)	300		300	300							
Chloride (ppm)	44	64	98	55	40	39	37	32		28	28
Chlorophyll A (µg/L)		0.5	3.4	3.1	10	10	3	3		0.5	0.5
Dissolved Inorganic Carbon (mg/L)		2	4		1.4	31	48	47		48	46
Dissolved Organic Carbon (mg/L)		52	47	44	5.6	1.7	1.1	0.8		0.9	0.7
flow rate (CFS)		1.1	2	1.5		36	14	11		40	39
Total Biochemical Oxygen Demand (5 day)		1	1	1	3	1	1	1		1	1
Total Organic Carbon (mg/L)		1.6	3	2.2	24	1.7	1.5	1.5		1.3	1.7
Total Volatile Suspended Solids (mg/L)		0.5	2	1	44	1	1	1		2	3

Site DRC 2	1/11/07	2/15/07	3/6/07	3/20/07	4/17/2007	4/3/2007	5/1/2007	5/15/2007	5/30/2007	6/13/2007	6/27/2007
Ammonia N as N (mg/L)	0.025		0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	190		5	30	5	550	50	80	360	390	230
Nitrate + Nitrite N (mg/L)	5.2		3.7	4.5	1.1	2.2	1.5	1.2	1.4	1.4	1.5
Total Kjeldahl N (mg/L)	0.4		0.7	0.4	0.2	1.1					
Total Phosphate (mg/L)	0.03		0.08	0.05	0.03	0.26	0.04		0.03	0.05	0.04
Ortho-phosphate (mg/L)	0.01		0.04	0.04	0.01	0.08	0.01	0.02	0.01	0.01	0.01
TSS (mg/L)	0.05		8	2	5	130	3	3	5	4	10
Temp ^{o}C	0.3		0.0	4.1	14.9	10.5	17.6	14.8	18.1	18.7	19.3
DO (mg/L)	17.5		14.8	12.8	13.7	11.6	10.1	9.9	7	8.8	9
pH	8.4		8.3	8.3	8.2	7.8	7.8	7.8	7.8	8	8
Turbidity (NTU)	1.9		7	4.6	3.2	138	2.6	2.1	3	3.4	5.7
Transp. (mm)	300		300	300	600	80	600	600	600	600	600
Chloride (ppm)	50		238	90							

Table 2-3B 2007 Water Quality

Site DRC 1	7/11/2007	7/23/2007	8/8/2007	8/22/2007	9/5/2007	9/19/2007	10/3/2007	10/17/2007	11/8/2007	12/5/2007
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	290	3700	640	700	570	2000	3100	320	160	120
Nitrate + Nitrite N (mg/L)	2.6	2.4	3.9	4.4	2.7	2.6	4.7	5.7	5.8	6.6
Total Kjeldahl N (mg/L)	0.05	0.8	0.3	0.8	0.05	0.05	0.4	0.3	0.1	0.3
Total Phosphate (mg/L)	0.06	0.16	0.06	0.24	0.03	0.04	0.12	0.04	0.04	0.02
Ortho-phosphate (mg/L)	0.01	0.04	0.04	0.13	0.01	0.02	0.07	0.03	0.01	0.01
TSS (mg/L)	2	87	17	41	2	2	21	5	1	3
TDS (mg/L)	320	290	380	320	330	320	320	330	350	600
Temp ^{o}C	18.3	19.5	19.6	20.8	20.9	17.9	15.1	13.7	7.6	1.1
DO (mg/L)	9.6	9.4	8.9	8.4	9.4	9.8	9.1	9	13.1	15.6
pH	8	7.6	7.7	7.7	8.1	7.9	7.9	7.8	8.1	7.6
Turbidity (NTU)	1.8	98	17	31	1.5	1.4	14	2.8	1.7	2.5
Transp. (mm)										
Chloride (ppm)	26	27	28	23	29	27	25	28	37	170
Chlorophyll A (µg/L)	0.5	9	2	2	1	2	6	0.5	3	2
Dissolved Inorganic Carbon (mg/L)	48	37	52	45	50	48	51	53	51	52
Dissolved Organic Carbon (mg/L)	0.9	3.6	1.3	3.8	0.7	1.2	2.4	1.1	1.6	1.4
flow rate (CFS)	26	61	47		35	33	73	35	14	6
Total Biochemical Oxygen Demand (5 day)	1	1	1	1	1	1	1	1	1	1
Total Organic Carbon (mg/L)	0.8	7.3	2.4	6.7	0.9	1.7	3.7	1.8	2.2	1.9
Total Volatile Suspended Solids (mg/L)	0.5	15	3	7	1	0.5	4	2	0.5	1

Site DRC 2	7/11/2007	7/23/2007	8/8/2007	8/22/2007	9/5/2007	9/19/2007	10/3/07	10/17/07	11/8/07	12/5/2007
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	
E.coli (colonies/100mL)	140	570	540	380	130	550	370	190	55	
Nitrate + Nitrite N (mg/L)	1.5	1.3	1.4	1.8	1.3	1.5	1.5	1.9	2.5	
Total Kjeldahl N (mg/L)	0.1	0.3	0.1	0.6	0.05	0.1	0.2	0.1	0.05	
Total Phosphate (mg/L)	0.03	0.06	0.04	0.11	0.03	0.03	0.05	0.02	0.04	
Ortho-phosphate (mg/L)	0.01	0.02	0.02	0.06	0.01	0.02	0.02	0.02	0.001	
TSS (mg/L)	4	16	20	20	6	1	5	2	0.5	
Temp ^{o}C	18.5	19.5	19.5	20.9	20.7	18	17.2	15.4	11	
DO (mg/L)	8.9	8.7	8.9	8.8	8.4	8.8	8.8	8	11	
pH	8.1	7.7	8.1	7.6	8.2	8.1	8	7.9	8.2	
Turbidity (NTU)		17.1	14.1	16.9	4	0.9	4.6	1.9	1.3	
Transp. (mm)	600	350	391	305	600	600	600	600	600	
Chloride (ppm)										

Table 2-3C 2007 Water Quality

Site DRC 3	1/11/2007	2/15/2007	3/6/2007	3/20/2007	4/17/2007	4/3/2007	5/1/2007	5/15/2007	5/30/2007	6/13/2007	6/27/2007
Ammonia N as N (mg/L)	0.025		0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	73		20	10	10	3200	110	270	500	290	600
Nitrate + Nitrite N (mg/L)	12		7.8	9.2	9	6.5	9	7.2	7.8	7.4	6.7
Total Kjeldahl N (mg/L)	0.1		0.4	0.3	0.4	2.1	0.2	0.2	0.1	0.2	0.3
Total Phosphate (mg/L)	0.04		0.05	0.05	0.05	0.65	0.04	0.02	0.04	0.04	0.04
Ortho-phosphate (mg/L)	0.01		0.02	0.03	0.03	0.22	0.02	0.01	0.01	0.01	0.02
TSS (mg/L)	2		5	6	4	280	5	4	7	6	10
Temp ^{o}C	1.9		0.4	4.2	11.4	9.2	14.9	14.9	18	19.4	20.3
DO (mg/L)	16.3		15.6	12.4	13.1	11	10.4	10.2	9	7.3	9.5
pH	8.4		8.2	8.2	8	7.7	7.8	7.9	7.8	8	8
Turbidity (NTU)	2.4		4.8	5.5	5	291	4.9	4.1	4.9	5.3	9.9
Transp. (mm)	600		600	600	600	40	600	600	600	600	558
Chloride (ppm)	43		90	57							

Site DRC 4	1/11/2007	2/15/2007	3/6/2007	3/20/2007	4/3/2007	4/17/2007	5/1/2007	5/15/2007	5/30/2007	6/13/2007	6/27/2007
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	110	20	30	30	5800	30	27	73	210	430	630
Nitrate + Nitrite N (mg/L)	11	8.5	8	9.2	6.6	8.2	8.4	5.6	6.1	5.7	5.6
Total Kjeldahl N (mg/L)	0.2	0.2	0.3	0.3	2	0.4	0.2	0.05	0.1	0.1	0.3
Total Phosphate (mg/L)	0.03	0.02	0.05	0.04	0.56	0.06	0.04	0.04	0.04	0.05	0.05
Ortho-phosphate (mg/L)	0.01	0.01	0.03	0.03	0.13	0.04	0.03	0.04	0.01	0.01	0.03
TSS (mg/L)	4	0.5	5	9	320	5	6	5	7	7	11
TDS (mg/L)		360	400	370	250	340	340	340	340	350	350
Temp ^{o}C	2.3	0.2	0.8	3.4	9.1	10.5	13.4	14.9	17.1	17.4	18.6
DO (mg/L)	15.7	15.2	16.2	12.5	11.1	12.6	10.8	9.2	8	8.4	8.9
pH	8.2	8.4	8.0	8.2	7.6	7.9	7.6	7.6	7.8	7.6	7.8
Turbidity (NTU)	2.8				240	2.1	2.3	1.8	2.9	3.8	4.1
Transp. (mm)	>600		>600	>600							
Chloride (ppm)	37	47	71	38	24	36	36	33	32	32	32
Chlorophyll A (µg/L)		0.5	2.7	5	14	12	2	2	1	0.5	0.5
Dissolved Inorganic Carbon (mg/L)		2	4		12	39	45	47	47	48	47
Dissolved Organic Carbon (mg/L)		50	48	43	5.4	1.1	0.9	0.9	0.7	0.7	0.9
flow rate (CFS)		1	1.3	1.4	87	22	8	11	21	22	22
Total Biochemical Oxygen Demand (5 day)		1	1	1	2	1	1	1	1	1	1
Total Organic Carbon (mg/L)		1.5	2.2	1.9	19	2.1	1.4	1.4	1.6	1.3	1.4
Total Volatile Suspended Solids (mg/L)		0.5	1	2	44	2	0.5	1	1	2	2

Table 2-3D 2007 Water Quality

Site DRC 3	7/11/2007	7/23/2007	8/8/2007	8/22/2007	9/5/2007	9/19/2007	10/3/2007	10/17/2007	11/8/2007	12/5/2007
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	
E.coli (colonies/100mL)	150	5300	2100	960	460	1000	920	430	120	
Nitrate + Nitrite N (mg/L)	3.3	3.2	5	4.9	3.5	3.3	5.6	6.6	6.8	
Total Kjeldahl N (mg/L)	0.2	0.9	0.3	0.9	0	0.2	0.4	0.3	0.1	
Total Phosphate (mg/L)	0.04	0.18	0.06	0.25	0.03	0.04	0.11	0.04	0.04	
Ortho-phosphate (mg/L)	0.01	0.05	0.04	0.14	0	0.02	0.08	0.001	0.001	
TSS (mg/L)	1	80	13	50	1	2	18	7	0.5	
Temp ^{o}C	20	19.6	20.2	20.8	21.2	18.4	15.8	13.8	7.6	
DO (mg/L)	9.4	8.5	9	8.3	9.2	9.1	9.1	8.8	14.5	
pH	8.1	7.7	7.9	7.7	7.9	7.9	7.9	7.9	8.8	
Turbidity (NTU)		104	11.7	43.3	2.8	2.7	15.9	6.2	3	
Transp. (mm)	600	84	521	172	600	600	398	600	600	
Chloride (ppm)										

Site DRC 4	7/11/2007	7/23/2007	8/8/2007	8/22/2007	9/5/2007	9/19/2007	10/3/2007	10/17/2007	11/8/2007	12/5/2007
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	350	2900	360	830	290	310	640	320	210	150
Nitrate + Nitrite N (mg/L)	3	3.3	3.3	4.7	3.1	3.2	5	5.9	6.4	6.9
Total Kjeldahl N (mg/L)	0.1	0.7	0.1	0.7	0.05	0.2	0.4	0.3	0.2	0.3
Total Phosphate (mg/L)	0.06	0.19	0.05	0.21	0.03	0.04	0.06	0.04	0.03	0.03
Ortho-phosphate (mg/L)	0.02	0.03	0.03	0.1	0.01	0.03	0.04	0.03	0.02	0.02
TSS (mg/L)	1	140	5	48	2	1	20	9	3	3
TDS (mg/L)	330	320	400	330	350	350	330	310	350	450
Temp ^{o}C	17.6	18.1	19	19.8	19.2	16.9	14.7	13.7	7.4	1.1
DO (mg/L)	8.6	9.2	8.5	8.4	8.1	8.7	8.5	8.7	11.7	14.2
pH	7.9	7.5	7.5	7.2	7.7	7.8	7.6	7.6	7.9	7.7
Turbidity (NTU)	1.2	190	4.2	40	1.6	1.1	12	4.5	2.8	2.2
Transp. (mm)										
Chloride (ppm)	31	27	32	22	32	33	28	29	32	85
Chlorophyll A (µg/L)	0.5	5	1	1	0.5	2	3	1	2	1
Dissolved Inorganic Carbon (mg/L)	50	42	52	45	52	50	53	54	50	50
Dissolved Organic Carbon (mg/L)	0.7	2.2	0.9	3.9	0.025	0.7	1.5	1	1.4	1.3
flow rate (CFS)	15	26	21	79	20	18	34	21	5	3
Total Biochemical Oxygen Demand (5 day)	1	1	3	1	1	1	1	1	1	1
Total Organic Carbon (mg/L)	0.8	6.3	1.4	5.1	0.8	1.2	2.8	1.7	1.8	1.6
Total Volatile Suspended Solids (mg/L)	0.5	21	1	8	1	1	4	2	2	0.5

Table 2-3E 2007 Water Quality

Site DRC 5	1/11/2007	2/15/2007	3/6/2007	3/20/2007	4/17/2007	4/3/2007	5/1/2007	5/15/2007	5/30/2007	6/13/2007	6/27/2007
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	110	45	10	100	20	1400	55	360	260	530	870
Nitrate + Nitrite N (mg/L)	12	9.3	8	9.3	12	7.1	12	12	14	14	12
Total Kjeldahl N (mg/L)	0.2	0.2	0.4	0.4	0.4	2.2	0.3	0.3	0.2	0.4	0.4
Total Phosphate (mg/L)	0.04	0.02	0.06	0.08	0.03	0.72	0.04	0.02	0.03	0.07	0.05
Ortho-phosphate (mg/L)	0.01	0.01	0.03	0.03	0.01	0.26	0.02	0.01	0.02	0.01	0.02
TSS (mg/L)	3	0.5	5	7	2	400	4	3	3	3	11
Temp °C	1.8	0.6	0.2	4.3	10.4	9.3	14.7	14.7	17.2	18.6	20.3
DO (mg/L)	16.2	14.5	14.7	13.0	12.4	10.8	11.4	9.3	9	8.9	9
pH	8.2	8.4	8.0	8.0	8	7.7	7.8	8.1	7.9	8	8
Turbidity (NTU)	3.1		4	6.5	3.5	273	3.6	2.4	3	3.5	8.6
Transp. (mm)	>600		>600	>600	600	50	600	600	600	600	508
Chloride (ppm)	43			65							

Site DRC 6	1/11/2007	2/15/2007	3/6/2007	3/20/2007	4/3/2007	4/17/2007	5/1/2007	5/15/2007	5/30/2007	6/13/2007	6/27/2007
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.08	0.025	0.4	0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	110	5	10	10	11000	150	60	180	4100	870	950
Nitrate + Nitrite N (mg/L)	13	9.4	9	9.6	7.2	12	14	12	14	13	12
Total Kjeldahl N (mg/L)	0.3	0.2	0.3	0.4	1.7	1.2	0.2	0.3	0.3	0.3	0.5
Total Phosphate (mg/L)	0.04	0.04	0.07	0.05	0.61	0.18	0.09	0.06	0.07	0.11	0.08
Ortho-phosphate (mg/L)	0.02	0.02	0.04	0.03	0.17	0.11	0.04	0.03	0.02	0.02	0.03
TSS (mg/L)	14	1	4	8	300	12	9	9	19	28	35
TDS (mg/L)		360	410	360	280	350	350	360	360	380	380
Temp °C	2.9	0.9	0.9	3.3	8.8	8.7	12.2	13.8	16.2	16.4	18.8
DO (mg/L)	14.2	13.8	14.6	12.7	10.6	12.9	11	9.1	8.9	8.1	8.3
pH	8.2	8.4	7.8	8.0	7.6	7.7	7.6	7.8	7.6	7.5	7.8
Turbidity (NTU)	7.2				280	4.9	5.2	5.9	12	20	21
Transp. (mm)	540		>600	>600							
Chloride (ppm) (test strips)	36	39	62	34	22	33	32	32	32	31	31
Chlorophyll A (µg/L)		1.1	2.8	3.9	6	39	3	2	3	2	2
Dissolved Inorganic Carbon (mg/L)		0.5	0.5		12	35	41	40	42	43	43
Dissolved Organic Carbon (mg/L)		50	48	43	4.7	2	1.6	1.5	1.7	1	1.6
flow rate (CFS)		1.1	1.6	1.1	31	6	2	1	3	3	3
Total Biochemical Oxygen Demand (5 day)		1	1	1	2	1	1	1	1	1	1
Total Organic Carbon (mg/L)		1.6	2	2	18	2.8	2.1	1.9	2.4	2.6	2.6
Total Volatile Suspended Solids (mg/L)		0.5	2	2	44	4	2	2	3	5	6

Table 2-3F 2007 Water Quality

Site DRC 5	7/11/2007	7/23/2007	8/8/2007	8/22/2007	9/5/2007	9/19/2007	10/3/2007	10/17/2007	11/8/2007	12/5/2007
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025		0.025	0.025	0.025	
E.coli (colonies/100mL)	1600	7700	2100	3100	570		910	260	90	
Nitrate + Nitrite N (mg/L)	6.2	3.4	7.9	4.7	5.3		6.5	8	7.4	
Total Kjeldahl N (mg/L)	0.5	1.2	0.5	1.1	0.2		0.5	0.4	0.2	
Total Phosphate (mg/L)	0.05	0.22	0.09	0.32	0.04		0.15	0.04	0.04	
Ortho-phosphate (mg/L)	0.02	0.09	0.06	0.19	0.02		0.12	0.03	0.001	
TSS (mg/L)	0.5	51	21	65	1		16	1	1	
Temp ^{o}C	20.7	20.5	20.2	20.1	21		15.5	13.8	14	
DO (mg/L)	7.8	8.8	8.1	8.3	9.1		9.1	9.1	6.6	
pH	8.2	7.7	7.9	7.5	8.2		7.8	7.9	8.8	
Turbidity (NTU)		53.2	17.2	61	2.6		15.9	3.3	2.3	
Transp. (mm)	600	152	390	148	600		393	600	600	
Chloride (ppm)										

Site DRC 6	7/11/2007	7/23/2007	8/8/2007	8/22/2007	9/5/2007	9/19/2007	10/3/2007	10/17/2007	11/8/2007	12/5/2007
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	570	2400	760	560	490	1200	1800	360	150	64
Nitrate + Nitrite N (mg/L)	8.4	3.6	5.7	5.6	6.2	5.4	6.1	8.6	7.7	7
Total Kjeldahl N (mg/L)	0.5	1.6	0.6	0.8	0.2	1.2	0.6	0.4	0.3	0.2
Total Phosphate (mg/L)	0.09	0.52	0.09	0.23	0.05	0.19	0.13	0.08	0.08	0.05
Ortho-phosphate (mg/L)	0.03	0.05	0.04	0.12	0.01	0.09	0.05	0.05	0.03	0.01
TSS (mg/L)	21	480	35	54	11	29	45	20	17	5
TDS (mg/L)	340	260	360	310	350	360	330	350	370	400
Temp ^{o}C	19.5	18.9	21.1	20.4	19.8	18.1	14.8	13.4	6.8	1.8
DO (mg/L)	7.4	8.3	7.2	8	7.3	6.7	8.5	8.4	12.1	13.2
pH	7.9	7.5	7.9	7.4	8	7.7	7.5	7.5	7.8	7.6
Turbidity (NTU)	20	630	33	47	8	26	42	13	16	3.9
Transp. (mm)										
Chloride (ppm) (test strips)	32	16	31	19	29	31	23	25	27	49
Chlorophyll A (µg/L)	3	11	3	1	3	32	4	1	2	0.5
Dissolved Inorganic Carbon (mg/L)	42	26	49	43	51	53	49	56	51	49
Dissolved Organic Carbon (mg/L)	1.7	4.9	2.7	3.9	1.6	3	2.6	1.7	1.6	1.2
flow rate (CFS)	0.6	5	1.5	26	2	1	3	6	1	0.5
Total Biochemical Oxygen Demand (5 day)	1	1	1	1	1	3	2	1	1	1
Total Organic Carbon (mg/L)	2.5	13	4.1	7.7	2.3	4	4.5	2.3	2.6	1.8
Total Volatile Suspended Solids (mg/L)	4	68	6	9	2	8	7	3	2	1

Table 2-3G 2007 Water Quality

Site DRC 7	1/11/2007	2/15/2007	3/6/2007	3/20/2007	4/17/2007	4/3/2007	5/1/2007	5/15/2007	5/30/2007	6/13/2007	6/27/2007
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	<10	<10	<10	5	5	540	30	5	5	10	91
Nitrate + Nitrite N (mg/L)	17	14	12	14	15	9.6	18	16	19	18	16
Total Kjeldahl N (mg/L)	0.2	0.1	0.1	0.1	0.2	1		0.1		0.1	
Total Phosphate (mg/L)	0.01	0.01	0.04	0.02	0.02	0.35	0.04	0.01	0.02	0.03	0.04
Ortho-phosphate (mg/L)	0.01	0.01	0.02	0.01	0.01	0.16	0.01	0.01	0.01	0.01	0.01
TSS (mg/L)	0.5	0.5	0.5	0.5	0.5	13	0.5	0.5	0.5	3	2
Temp ^{o}C	5.6	3.1	3.2	3.3	5.5	8.7	7.8	10.2	12.4	14	15.6
DO (mg/L)	12.2	13.0	11.9	11.8	11.2	9.8	10.5	9.9	9	8	8.1
pH	7.6	8.3	7.6	8.0	7.5	8	7.5	7.6	7.2	7	7.7
Turbidity (NTU)	0.9		0.9	0.7	1	52.9	1.1	0.6	1.5	1.9	1.1
Transp. (mm)	600		600	600	600	110	600	600	600	600	600
Chloride (ppm)	30		15	15							

Site DRC 8	1/11/2007	2/15/2007	3/6/2007	3/20/2007	4/17/2007	4/3/2007	5/1/2007	5/15/2007	5/30/2007	6/13/2007	6/27/2007
Ammonia N as N (mg/L)	0.025		0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	91		5	82	5	680	50	160	140	330	610
Nitrate + Nitrite N (mg/L)	13		8.5	11	13	8.9	14	13	16	15	12
Total Kjeldahl N (mg/L)	0.4		0.4	0.4	0.3	1.8	0.2	0.3	0.4	0.2	0.4
Total Phosphate (mg/L)	0.05		0.05	0.05	0.03	0.54	0.05	0.03	0.03	0.05	0.05
Ortho-phosphate (mg/L)	0.01		0.02	0.04	0.01	0.25	0.02	0.01	0.01	0.01	0.01
TSS (mg/L)	14		5	7	3	200	6	2	3	4	22
Temp ^{o}C	2.3		2.1	4.9	10.9	9.3	15	13.5	16.9	18.9	19.6
DO (mg/L)	14.5		13.0	11.6	11.5	10.5	10.5	7.1	9.1	8.1	8.3
pH	8.3		7.8	8.0	8	7.7	7.8	7.8	8	8	7.9
Turbidity (NTU)	13.1		3.9	6.8	3.3	178	4.2	2.7	2.7	3.7	14.3
Transp. (mm)	450		>600	>600	600	55	600	600	600	600	441
Chloride (ppm)	50		81	65							

Table 2-3H 2007 Water Quality

Site DRC 7	7/11/2007	7/23/2007	8/8/2007	8/22/2007	9/5/2007	9/19/2007	10/3/2007	10/17/2007	11/8/2007	12/5/2007
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	
E.coli (colonies/100mL)	280	220	210	1000	110	55	220	45	10	
Nitrate + Nitrite N (mg/L)	16	12	13	6.3	9.1	9.6	9.2	13	9.9	
Total Kjeldahl N (mg/L)	0.2	0.2		0.6	0.05	0.06	0.2	0.3	0.05	
Total Phosphate (mg/L)	0.05	0.03	0.02	0.22	0.03	0.02	0.08	0.02	0.03	
Ortho-phosphate (mg/L)	0.01	0.01	0.02	0.17	0.01	0.01	0.07	0.001	0.001	
TSS (mg/L)	2	5	4	4	5	1	2	2	1	
Temp °C	16.5	16.8	17.8	20.7	17.6	16.6	15.8	15.2	12	
DO (mg/L)	8.4	6.4	7.2	5.7	4.7	7.6	6.9	6.1	9.3	
pH	7.7	7.1	7.4	7.3	7.5	7.9	7.5	7.1	7.4	
Turbidity (NTU)		2.5	2.1	4.9	1.8	0.7	10.5	1.2	1.1	
Transp. (mm)	600	600	600	600	600	600	600	600	600	
Chloride (ppm)										

Site DRC 8	7/11/2007	7/23/2007	8/8/2007	8/22/2007	9/5/2007	9/19/2007	10/3/2007	10/17/2007	11/8/2007	12/5/2007
Ammonia N as N (mg/L)	0.025	0.06	0.025	0.025	0.025	0.025	0.025	0.025	0.025	
E.coli (colonies/100mL)	600	4600	560	2400	360	600	710	170	45	
Nitrate + Nitrite N (mg/L)	7.2	4.3	8.5	5.2	6.1	5.3	7.1	8.5	8.1	
Total Kjeldahl N (mg/L)	0.3	1	0.4	1	0.3	0.4	0.5	0.4	0.2	
Total Phosphate (mg/L)	0.04	0.25	0.08	0.33	0.04	0.04	0.14	0.04	0.03	
Ortho-phosphate (mg/L)	0.02	0.13	0.05	0.19	0.02	0.02	0.1	0.03	0.001	
TSS (mg/L)	2	33	14	56	2	2	19	5	1	
Temp °C	20.1	20.7	20.3	20.8	20.3	18.7	16.2	14.3	7.7	
DO (mg/L)	8.1	8.5	7.3	7.7	8.2	8.9	8.4	8.4	11.5	
pH	8.2	7.7	7.8	7.5	7.8	8.2	7.9	7.8		
Turbidity (NTU)		43	12.5	47.5	2.9	4.5	16	4.6	3.3	
Transp. (mm)	600	176	559	181	600	600	390	600	600	

Table 2-3I 2007 Water Quality

Site DRC 9	1/11/2007	2/15/2007	3/6/2007	3/20/2007	4/17/2007	4/3/2007	5/1/2007	5/15/2007	5/30/2007	6/13/2007	6/27/2007
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	55	5	40	55	5	1400	20	90	210	270	530
Nitrate + Nitrite N (mg/L)	12	9.4	8.6	11	12	9	14	13	15	15	15
Total Kjeldahl N (mg/L)	0.2	0.2	0.2	0.2	0.4	1.6	0.1	0.2	0.2	0.2	0.4
Total Phosphate (mg/L)	0.04	0.01	0.05	0.04	0.03	0.53	0.04	0.03	0.02	0.05	0.04
Ortho-phosphate (mg/L)	0.02	0.02	0.03	0.03		0.25	0.02				0.02
TSS (mg/L)	8	1	4	8	7	150	14	5	5	7	14
Temp ^{o}C	2.9	0.1	1.4	2.5	6.9	8.3	10.3	11.7	14.6	15	16.8
DO (mg/L)	13.7	15.1	13.8	12.5	12.8	10.6	11.3	10.5	10.3	9.1	8.5
pH	7.8	8.0	7.6	8.1	7.6	8	7.8	7.6	7.6	7.7	7.7
Turbidity (NTU)	3		2.8	5.2	3.5	163	5.8	3.1	3.2	3.4	5.9
Transp. (mm)	>600		>600	>600	600	60	600	600	600	600	600
Chloride (ppm)	43		43	36							

Site DRC 10	1/11/2007	2/15/2007	3/6/2007	3/20/2007	4/3/2007	4/17/2007	5/1/2007	5/15/2007	5/30/2007	6/13/2007	6/27/2007
Ammonia N as N (mg/L)	0.08		0.025	0.06	0.025		0.025	0.025	0.025	0.025	0.025
E.coli (colonies/100mL)	250		45	370	3100		10	100	250	780	950
Nitrate + Nitrite N (mg/L)	15		11	14	7.2		17	15	17	17	17
Total Kjeldahl N (mg/L)	0.8		0.6	0.4	2.7		0.3	0.3	0.2	0.4	0.3
Total Phosphate (mg/L)	0.16		0.09	0.06	0.92		0.04		0.04	0.04	0.04
Ortho-phosphate (mg/L)	0.02		0.03	0.03	0.38		0.02	0.02	0.02		0.02
TSS (mg/L)	110		29	11	270		5	2	3	8	4
Temp ^{o}C	2.1		0.4	2.0	9		11.4	13	14.6	14.9	17.1
DO (mg/L)	13.9		14.5	13.3	10.6		11.4	10.1	10.3	9.5	10
pH	7.6		7.5	8.2	8		7.9	7.6	7.6	7.6	7.5
Turbidity (NTU)	79.2		10.3	7.4	402		5.3	1.9	2.7	4.9	3.5
Transp. (mm)	160		>600	>600	30		600	600	600	600	600
Chloride (ppm)	43		65	57							

Table 2-3J 2007 Water Quality

Site DRC 9	7/11/2007	7/23/2007	8/8/2007	8/22/2007	9/5/2007	9/19/2007	10/3/2007	10/17/2007	11/8/2007	12/5/2007
Ammonia N as N (mg/L)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	
E.coli (colonies/100mL)	950	2500	540	450	460	800	530	440	370	
Nitrate + Nitrite N (mg/L)	9.4	7.1	7	6.3	6.2	6.5	7.8	8.5	7.9	
Total Kjeldahl N (mg/L)	0.3	0.8	0.2	0.7	0.01	0.2	0.4	0.3	0.1	
Total Phosphate (mg/L)	0.05	0.15	0.12	0.19	0.03	0.05	0.08	0.04	0.05	
Ortho-phosphate (mg/L)	0.03	0.08	0.04	0.13	0.01	0.03	0.04	0.03	0.001	
TSS (mg/L)	6	33	3	19	6	9	30	14	5	
Temp ^{o}C	16.3	17.7	19.8	20.6	18.2	16.6	15.4	14.4	8.6	
DO (mg/L)	5.1	8.1	5.9	7.2	8.8	8.2	8.4	8.1	11.4	
pH	7.8	7.3	7.7	7.5	7.9	7.8	7.5	7.3	7.4	
Turbidity (NTU)		18	2.9	15.4	5	6.4	12.8	7	4.9	
Transp. (mm)	500	342	600	486	600	600	436	600	600	
Chloride (ppm)										

Site DRC 10	7/11/2007	7/23/2007	8/8/2007	8/22/2007	9/5/2007	9/19/2007	10/3/2007	10/17/2007	11/8/2007	12/5/2007
Ammonia N as N (mg/L)	0.025	0.15	0.025	0.025	0.025	0.025	0.025	0.025	0.025	
E.coli (colonies/100mL)	600	12000	410	630	320	870	2400	110	110	
Nitrate + Nitrite N (mg/L)	9	4.8	9.9	6.5	7.4	6.7	8	9.6	9.2	
Total Kjeldahl N (mg/L)	0.3	1.3	0.3	0.9	0.3	0.4	0.6	0.3	0.2	
Total Phosphate (mg/L)		0.31	0.07	0.3	0.05	0.04	0.19	0.04	0.07	
Ortho-phosphate (mg/L)		0.2	0.06	0.2	0.02	0.02	0.14	0.04	0.001	
TSS (mg/L)	4	24	12	23	5	3	33	7	15	
Temp ^{o}C	16.9	18.9	20	20.8	18.2	17	8.4	8.9	11.8	
DO (mg/L)	8.3	7.3	8.1	7.5	8.4	8.7	8.3	7.9	7.5	
pH	7.7	7.7	7.7	7.7	7.5	7.8				
Turbidity (NTU)		32.7	9.7	29.7	5.3	4.5				
Transp. (mm)	600	220	600	270	600	600				
Chloride (ppm)										

Table 2-4 Water Quality Statistics

DRC 1	Ammonia	E.coli	Nitrate + Nitrite N	Total Kjeldahl N	Total Phosphate	Ortho-phosphate	TSS	Total Dissolved Solids	Temp ºC	DO	% DO Saturation
Min	0.03	130.00	1.00	0.05	0.01	0.01	0.50	280.00	7.80	4.80	57.14
Max	0.09	34000.00	7.60	0.90	0.28	0.13	87.00	380.00	22.10	13.30	147.78
Mean	0.03	2379.68	2.88	0.25	0.07	0.04	14.03	323.75	17.23	9.04	96.82
Median	0.03	630.00	2.30	0.16	0.04	0.02	4.00	320.00	18.10	9.25	100.97
Count	31.00	31.00	31.00	31.00	31.00	17.00	17.00	16.00	28.00	28.00	27.00
Stand. Dev	0.01	6104.44	1.53	0.26	0.07	0.04	22.55	23.63	3.31	1.69	16.74
Stand. Error	0.00	1096.39	0.27	0.05	0.01	0.01	5.47	5.91	0.63	0.32	3.22

DRC 1	pH	Turbidity (NTU)	Chloride (ppm)	Chlorophyll A	Dissolved Inorganic Carbon	Dissolved Organic Carbon	Flow Rate	Total Biochemical Oxygen Demand (5 day)	Total Organic Carbon	Total Volatile Suspended Solids
Min	7.60	0.50	23.00	0.50	37.00	0.70	12.00	1.00	0.80	0.50
Max	8.40	98.00	33.00	9.00	53.00	3.80	104.00	1.00	7.30	15.00
Mean	8.02	12.75	26.71	2.88	48.00	1.88	38.73	1.00	3.16	4.13
Median	8.00	2.20	27.00	2.00	49.00	1.25	28.00	1.00	2.10	2.50
Count	19.00	16.00	17.00	8.00	8.00	8.00	15.00	8.00	8.00	8.00
Stand. Dev	0.26	24.59	3.04	3.03	5.13	1.23	23.82	0.00	2.54	4.90
Stand. Error	0.06	6.15	0.74	1.07	1.81	0.44	6.15	0.00	0.90	1.73

Table 2-4B Water Quality Statistics

DRC 2	Ammonia	E.coli	Nitrate + Nitrite N	Total Kjeldahl N	Total Phosphate	Ortho-phosphate	TSS	Temp ºC	DO	% DO Saturation	pH	Turbidity (NTU)	Transp. (mm)	Chloride (ppm)
Min	0.03	40.00	0.09	0.05	0.02	0.01	1.00	7.90	6.00	67.42	7.60	0.90	305.00	29.00
Max	0.15	3000.00	7.00	0.90	0.18	0.14	20.00	21.20	13.20	114.78	8.40	17.10	600.00	39.00
Mean	0.03	412.17	1.45	0.16	0.05	0.03	6.06	17.52	8.18	88.03	8.02	5.49	537.17	34.00
Median	0.03	220.00	1.30	0.10	0.04	0.02	3.00	18.40	8.20	88.51	8.00	2.54	600.00	34.00
Count	29.00	29.00	29.00	29.00	29.00	16.00	16.00	26.00	26.00	26.00	17.00	15.00	12.00	2.00
Stand. Dev	0.02	564.96	1.13	0.19	0.04	0.03	6.59	3.10	1.53	13.11	0.25	5.74	115.14	7.07
Stand. Error	0.00	104.91	0.21	0.03	0.01	0.01	1.65	0.61	0.30	2.57	0.06	1.48	33.24	5.00

Table 2-4C Water Quality Statistics

DRC 3	Ammonia	E.coli	Nitrate + Nitrite N	Total Kjeldahl N	Total Phosphate	Ortho-phosphate	TSS	Temp ºC	DO	% DO Saturation	pH	Turbidity (NTU)	Transp. (mm)	Chloride (ppm)
Min	0.03	100.00	0.08	0.00	0.01	0.00	0.50	11.30	5.60	68.29	7.70	0.88	84.00	27.00
Max	0.03	42000.00	8.70	0.98	0.32	0.14	80.00	23.20	10.80	112.22	8.30	104.00	600.00	48.00
Average	0.03	2793.67	3.47	0.28	0.07	0.04	13.97	18.14	8.44	92.20	7.94	15.30	472.25	33.57
Median	0.03	485.00	3.05	0.20	0.04	0.02	4.50	19.50	8.80	93.27	7.90	5.20	600.00	33.00
count	30.00	30.00	30.00	30.00	30.00	16.00	16.00	27.00	27.00	27.00	17.00	15.00	12.00	7.00
Stand. Dev	0.00	7864.53	1.80	0.26	0.07	0.04	22.05	3.39	1.37	11.99	0.17	27.07	189.62	7.83
Stand. Error	0.00	1435.86	0.33	0.05	0.01	0.01	5.51	0.65	0.26	2.31	0.04	6.99	54.74	2.96

Table 2-4D Water Quality Statistics

DRC 4	Ammonia	E.coli	Nitrate + Nitrite N	Total Kjeldahl N	Total Phosphate	Ortho-phosphate	TSS	Total Dissolved Solids	Temp ºC	DO	% DO Saturation
Min	0.03	60.00	2.10	0.05	0.02	0.01	1.00	310.00	8.10	5.90	65.93
Max	0.33	3400.00	7.80	1.40	0.30	0.23	140.00	400.00	23.00	11.80	128.26
Average	0.03	593.23	3.39	0.23	0.07	0.04	16.94	343.13	17.13	8.30	88.84
Median	0.03	310.00	3.00	0.12	0.05	0.03	4.00	345.00	17.70	8.50	88.07
N	31.00	31.00	31.00	31.00	31.00	17.00	17.00	16.00	28.00	28.00	28.00
Stand. Dev	0.05	873.49	1.34	0.27	0.06	0.05	33.94	23.30	3.09	1.33	12.86
Stand. Error	0.01	156.88	0.24	0.05	0.01	0.01	8.23	5.83	0.58	0.25	2.43

DRC 4	pH	Turbidity (NTU)	Chloride (ppm)	Chlorophyll A	Dissolved Inorganic Carbon	Dissolved Organic Carbon	Flow Rate	Total Biochemical Oxygen Demand (5 day)	Total Organic Carbon	Total Volatile Suspended Solids
Min	7.20	1.10	22.00	0.50	42.00	0.03	6.00	1.00	0.80	0.50
Max	8.20	190.00	36.00	5.00	54.00	3.90	79.00	3.00	6.30	21.00
Average	7.77	20.18	30.73	1.75	49.75	1.37	23.69	1.25	2.51	4.81
Median	7.80	3.80	31.00	1.00	51.00	0.95	19.00	1.00	1.55	1.50
N	19.00	14.00	15.00	8.00	8.00	8.00	16.00	8.00	8.00	8.00
Stand. Dev	0.28	49.94	3.31	1.56	4.17	1.21	16.87	0.71	2.09	7.00
Stand. Error	0.06	13.35	0.85	0.55	1.47	0.43	4.22	0.25	0.74	2.47

Table 2-4E Water Quality Statistics

DRC 5	Ammonia	E.coli	Nitrate + Nitrite N	Total Kjeldahl N	Total Phosphate	Ortho-phosphate	TSS	Temp ºC	DO	% DO Saturation	pH	Turbidity (NTU)	Transp. (mm)	Chloride (ppm)
Min	0.03	55.00	0.00	0.20	0.03	0.01	0.50	5.80	4.70	57.47	7.50	1.19	148.00	46.00
Max	0.30	260000.00	11.00	4.60	0.44	0.19	65.00	24.40	13.50	127.91	8.60	61.00	600.00	64.00
Average	0.04	23461.90	4.69	0.68	0.11	0.06	13.93	18.35	7.92	86.18	8.00	14.53	451.27	54.00
Median	0.03	3100.00	4.90	0.50	0.07	0.03	2.00	20.15	8.10	90.85	8.00	4.10	600.00	54.50
count	29.00	29.00	29.00	29.00	29.00	15.00	15.00	26.00	26.00	26.00	16.00	14.00	11.00	8.00
Stand. Dev	0.05	57158.14	3.66	0.80	0.10	0.05	20.79	4.67	2.07	18.22	0.29	19.62	187.19	6.48
Stand. Error	0.01	10614.00	0.68	0.15	0.02	0.01	5.37	0.92	0.41	3.57	0.07	5.24	56.44	2.29

Table 2-4F Water Quality Statistics

DRC 6	Ammonia	E.coli	Nitrate + Nitrite N	Total Kjeldahl N	Total Phosphate	Ortho-phosphate	TSS	Total Dissolved Solids	Temp ºC	DO	% DO Saturation
Min	0.03	30.00	0.03	0.20	0.04	0.01	3.00	260.00	4.50	3.40	40.00
Max	2.00	5100.00	14.00	46.00	5.90	0.89	480.00	410.00	24.20	11.70	111.76
Average	0.17	1019.36	5.32	2.58	0.42	0.10	45.53	360.63	18.54	7.01	77.11
Median	0.03	565.00	5.65	0.60	0.10	0.04	20.00	360.00	19.50	7.20	80.25
count	28.00	28.00	28.00	28.00	28.00	17.00	17.00	16.00	27.00	27.00	27.00
Stand. Dev	0.48	1301.98	3.82	8.58	1.11	0.21	112.97	40.24	4.51	1.81	16.68
Stand. Error	0.09	246.05	0.72	1.62	0.21	0.05	27.40	10.06	0.87	0.35	3.21

DRC 6	pH	Turbidity (NTU)	Chloride (ppm)	Chlorophyll A	Dissolved Inorganic Carbon	Dissolved Organic Carbon	Flow Rate	Total Biochemical Oxygen Demand (5 day)	Total Organic Carbon	Total Volatile Suspended Solids
Min	7.40	1.20	16.00	1.00	26.00	1.60	0.60	1.00	2.30	2.00
Max	8.40	630.00	41.00	32.00	56.00	4.90	26.00	3.00	13.00	68.00
Average	7.78	54.11	28.86	7.25	46.13	2.76	5.64	1.38	5.05	13.38
Median	7.70	12.00	30.50	3.00	49.00	2.65	2.50	1.00	4.05	6.50
count	18.00	16.00	14.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Stand. Dev	0.27	154.24	6.41	10.48	9.39	1.17	8.45	0.74	3.67	22.21
Stand. Error	0.06	38.56	1.71	3.71	3.32	0.41	2.99	0.26	1.30	7.85

Table 2-4G Water Quality Statistics

DRC 7	Ammonia	E.coli	Nitrate + Nitrite N	Total Kjeldahl N	Total Phosphate	Ortho-phosphate	TSS	Temp ºC	DO	% DO Saturation	pH	Turbidity (NTU)	Transp. (mm)	Chloride (ppm)
Min	0.03	10.00	5.20	0.05	0.01	0.01	0.50	12.00	4.70	51.09	7.10	0.70	600.00	27.00
Max	0.03	2200.00	19.00	1.10	0.22	0.21	10.00	20.70	8.40	89.36	8.10	10.50	600.00	34.00
Average	0.03	321.90	13.02	0.29	0.07	0.04	3.53	16.97	6.62	70.68	7.51	3.11	600.00	29.60
Median	0.03	210.00	14.00	0.20	0.04	0.01	3.50	17.10	6.65	70.72	7.50	2.10	600.00	27.00
count	21.00	21.00	21.00	21.00	21.00	16.00	16.00	20.00	20.00	20.00	17.00	15.00	12.00	5.00
Stand. Dev	0.00	498.31	3.69	0.27	0.07	0.06	2.51	1.92	1.08	10.12	0.31	2.67	0.00	3.58
Stand. Error	0.00	108.74	0.81	0.06	0.01	0.02	0.63	0.43	0.24	2.26	0.08	0.69	0.00	1.60

Table 2-4H Water Quality Statistics

DRC 8	Ammonia	E.coli	Nitrate + Nitrite N	Total Kjeldahl N	Total Phosphate	Ortho-phosphate	TSS	Temp ºC	DO	% DO Saturation	pH	Turbidity (NTU)	Transp. (mm)	Chloride (ppm)
Min	0.03	27.00	0.47	0.20	0.02	0.01	1.00	6.50	4.50	51.14	7.50	1.33	176.00	46.00
Max	0.10	12000.00	13.00	1.00	0.33	0.19	56.00	24.60	13.00	109.24	8.30	47.50	600.00	56.00
Average	0.03	1458.23	5.28	0.46	0.09	0.05	11.06	18.53	7.45	81.36	7.94	11.16	490.42	52.00
Median	0.03	505.00	5.25	0.40	0.06	0.03	2.50	19.80	7.30	83.33	7.90	4.00	600.00	53.00
count	30.00	30.00	30.00	30.00	30.00	16.00	16.00	28.00	28.00	28.00	17.00	15.00	12.00	8.00
Stand. Dev	0.02	2636.32	3.78	0.21	0.08	0.05	15.79	4.14	1.71	12.80	0.26	14.83	166.75	4.11
Stand. Error	0.00	481.32	0.69	0.04	0.01	0.01	3.95	0.78	0.32	2.42	0.06	3.83	48.14	1.45

Table 2-4I Water Quality Statistics

DRC 9	Ammonia	E.coli	Nitrate + Nitrite N	Total Kjeldahl N	Total Phosphate	Ortho-phosphate	TSS	Temp ºC	DO	% DO Saturation	pH	Turbidity (NTU)	Transp. (mm)	Chloride (ppm)
Min	0.03	150.00	1.00	0.01	0.02	0.01	3.00	6.90	5.10	53.68	7.10	2.44	342.00	27.00
Max	0.09	2700.00	14.00	1.20	0.50	0.13	38.00	21.10	10.80	96.70	8.40	20.10	600.00	48.00
Average	0.03	795.67	6.84	0.34	0.09	0.04	13.19	16.85	7.12	75.32	7.78	7.88	530.33	35.13
Median	0.03	550.00	7.05	0.30	0.07	0.04	10.00	17.30	6.80	74.49	7.80	6.00	600.00	34.00
count	30.00	30.00	30.00	30.00	30.00	16.00	16.00	28.00	28.00	28.00	17.00	15.00	12.00	8.00
Stand. Dev	0.02	737.81	3.41	0.23	0.09	0.03	11.38	3.52	1.45	10.76	0.41	6.48	109.61	6.92
Stand. Error	0.00	134.70	0.62	0.04	0.02	0.01	2.84	0.66	0.27	2.03	0.10	1.67	31.64	2.45

Table 2-4J Water Quality Statistics

DRC 10	Ammonia	E.coli	Nitrate + Nitrite N	Total Kjeldahl N	Total Phosphate	Ortho-phosphate	TSS	Temp ºC	DO	% DO Saturation	pH	Turbidity (NTU)	Transp. (mm)	Chloride (ppm)
Min	0.03	73.00	0.05	0.10	0.03	0.01	2.00	5.70	4.20	51.22	7.50	1.58	220.00	39.00
Max	0.15	29000	16.00	1.30	0.31	0.20	33.00	23.50	11.50	107.07	8.60	32.70	600.00	56.00
Average	0.03	2111.10	6.47	0.41	0.09	0.07	10.38	17.47	7.31	78.22	7.99	10.35	498.83	47.38
Median	0.03	450.00	7.05	0.30	0.07	0.03	7.00	18.10	7.00	80.46	7.90	5.20	600.00	48.00
count	30.00	30.00	30.00	30.00	29.00	15.00	16.00	27.00	27.00	27.00	17.00	15.00	12.00	8.00
Stand. Dev	0.02	5635.11	5.26	0.25	0.07	0.07	9.22	4.11	1.68	13.46	0.33	10.41	161.88	4.63
Stand. Error	0.00	1028.83	0.96	0.05	0.01	0.02	2.30	0.79	0.32	2.59	0.08	2.69	46.73	1.64

Table 2-5 47C Ecoregion Reference Site Statistics July 1 – October 31

	Ammonia Nitrogen as N	Atrazine Screen	DO	Flow	Hardness	Nitrate + Nitrite as N	pH	Specific Conductance	TDS	Temperature	TKN	Total Phosphorus as P	TSS	Turbidity
N	16	19	19	20	19	19	19	19	19	19	19	19	19	19
Mean	0.06	0.15	8.62	21.73	273.59	4.96	7.79	537.91	299.75	17.96	0.66	0.11	20.21	8.80
SD	0.02	0.05	1.16	19.20	57.22	2.04	0.25	87.33	40.61	2.85	0.36	0.05	31.30	5.39
Min	0.05	0.07	6.80	3.10	200.00	1.80	7.30	350.00	235.00	12.00	0.30	0.06	3.50	3.15
25%	0.05	0.12	7.90	7.85	235.00	3.65	7.60	495.00	275.00	14.75	0.39	0.09	7.50	5.15
Median	0.05	0.14	8.35	14.50	260.00	5.00	7.85	535.00	295.00	19.25	0.50	0.10	10.50	8.00
75%	0.06	0.18	9.00	35.54	281.67	6.80	7.95	593.33	320.00	20.25	0.83	0.14	15.50	9.10
Max	0.10	0.29	11.60	79.50	400.00	8.25	8.10	750.00	410.00	21.60	1.55	0.24	137.00	26.80

Table 2-6. Statewide and Ecoregion Chlorophyll a Statistics from REMAP Data Set

	Chlorophyll a 47 c Data			Chlorophyll a Statewide Data		
	SEDIMENT	PERIPHYTON	WATER	SEDIMENT	PERIPHYTON	WATER
N	32	32	32	222	222	228
MEAN	5.21	8.84	41.09	5.45	8.70	36.48
SD	4.90	6.45	74.96	6.19	15.04	62.55
MINIMUM	0.55	0.95	1.00	0.10	0.10	1.00
1STQUARTILE	1.91	3.54	5.13	1.64	2.64	4.75
MEDIAN	3.08	7.23	9.00	3.15	5.08	9.58
3RDQUARTILE	7.79	12.64	32.95	7.02	10.36	32.33
MAXIMUM	22.125	29.575	320	43	148.15	360

Table 2-7 REMAP Statewide Statistics

	Ammonia Nitrogen as N	Chloride	Chlorophyll A	Chlorophyll B	Chlorophyll C	Corrected Chlorophyll A	Dissolved Oxygen	Field pH	Field Temperature	Flow Rate
N	506	507	507	318	318	325	505	501	505	501
mean	0.16	26.42	38.13	1.86	2.09	25.57	8.99	8.16	20.36	126.29
SD	0.74	30.49	70.66	3.54	3.34	51.66	2.42	0.34	5.01	512.79
min	0.05	3.3	1	1	1	1	1.4	7	5.45	0.1
25%	0.05	15	5	1	1	3	7.7	8	17.4	2.7
median	0.05	20	10	1	1	7	8.8	8.2	21	11.3
75%	0.05	28	34	1	1	22	10.2	8.3	23.8	62
max	12	360	570	37	23	420	19	9.3	33.7	8000

	Nitrate + Nitrite Nitrogen as N	Ortho Phosphate as P	Pheophytin	Silica as SiO2	TKN	Total Arsenic	Total Cadmium	Total Chromium	Total Copper	Total Dissolved Solids
N	507	507	318	507	507	212	212	212	212	507
mean	5.33	0.20	4.96	14.72	1.10	0.01	0.00	0.02	0.01	406.23
SD	4.67	1.26	6.44	6.30	1.50	0.00	0.00	0.00	0.00	172.08
min	0.05	0.02	1	1	0.05	0.001	0.001	0.02	0.01	77
25%	1.3	0.04	1	10	0.5	0.01	0.001	0.02	0.01	320
median	4.5	0.07	3	14	0.72	0.01	0.001	0.02	0.01	370
75%	7.6	0.13	6	19	1.2	0.01	0.001	0.02	0.01	450
max	26	20	61	35	20	0.05	0.001	0.02	0.02	2210

	Total Lead	Total Mercury	Total Nickel	Total Phosphate as P	Total Selenium	Total Silver	Total Suspended Solids	Total Volatile Suspended Solids	Total Zinc	Turbidity
N	212	212	212	507	212	212	507	507	212	507
mean	0.01	0.00	0.05	0.34	0.01	0.01	42.86	8.08	0.02	25.71
SD	0.00	0.00	0.01	1.74	0.00	0.00	51.95	9.63	0.00	51.84
min	0.001	0.00005	0.05	0.02	0.01	0.01	1	1	0.02	1
25%	0.01	0.00005	0.05	0.1	0.01	0.01	10	2	0.02	5.65
median	0.01	0.00005	0.05	0.17	0.01	0.01	25	5	0.02	14
75%	0.01	0.00005	0.05	0.27	0.01	0.01	57.5	11	0.02	30
max	0.03	0.0002	0.11	30	0.02	0.01	420	100	0.04	700

Table 2-8 Storm Event Sampling Site DRC 1

Result Analyte	Type	Concentration	Unit
DRC 1 8/18/2006			
Ammonia Nitrogen as N	E	<0.05	mg/L
Chloride	E	24	mg/L
Chlorophyll A	E	1	ug/L
Dissolved Inorganic Carbon	E	46	mg/L
Dissolved Organic Carbon	E	2.1	mg/L
E.coli	E	1000	/100mL
E.coli	G	460	/100mL
Nitrate + Nitrite Nitrogen as N	E	1.8	mg/L
Ortho Phosphate as P	E	<0.02	mg/L
Total Biochemical Oxygen Demand (5 day)	E	3	mg/L
Total Dissolved Solids	E	290	mg/L
Total Kjeldahl Nitrogen as N	E	0.2	mg/L
Total Organic Carbon	E	2.9	mg/L
Total Phosphate as P	E	0.07	mg/L
Total Suspended Solids	E	4	mg/L
Total Volatile Suspended Solids	E	2	mg/L
Turbidity	E	2.8	NTU
E = Event Composite Sample G = Grab Sample			

Table 2-8B Storm Event Sampling Site DRC 1

Result Analyte	Type	Concentration	Unit
DRC 1 8/29/2006			
Ammonia Nitrogen as N	E	<0.05	mg/L
Chloride	E	23	mg/L
Chlorophyll A	E	3	ug/L
Dissolved Inorganic Carbon	E	41	mg/L
Dissolved Organic Carbon	E	4.1	mg/L
E.coli	E	3900	/100mL
Nitrate + Nitrite Nitrogen as N	E	1.4	mg/L
Ortho Phosphate as P	E	<0.02	mg/L
Total Biochemical Oxygen Demand (5 day)	E	6	mg/L
Total Dissolved Solids	E	250	mg/L
Total Kjeldahl Nitrogen as N	E	0.3	mg/L
Total Organic Carbon	E	5.7	mg/L
Total Phosphate as P	E	0.06	mg/L
Total Suspended Solids	E	23	mg/L
Total Volatile Suspended Solids	E	6	mg/L
Turbidity	E	6.1	NTU
E = Event Composite Sample G = Grab Sample			

Table 2-8C Storm Event Sampling Site DRC 1

Result Analyte	Type	Concentration	Unit
DRC 1 9/23/2006			
Acetone	E	13	ug/L
bis(2-Ethylhexyl)phthalate	E	150	ug/L
Bromoxynil	E	0.21	ug/L
Chloride	E	27	mg/L
Chlorophyll A	E	6	ug/L
Dissolved Inorganic Carbon	E	41	mg/L
Dissolved Organic Carbon	E	3.6	mg/L
Dissolved Oxygen	G	10.2	mg/L
E.coli	E	2000	/100mL
E.coli	G	520	/100mL
Field pH	G	8.2	pH Units
Field Temperature	G	13.8	Degrees C
Nitrate + Nitrite Nitrogen as N	E	3.9	mg/L
Ortho Phosphate as P	E	0.03	mg/L
Total Biochemical Oxygen Demand (5 day)	E	4	mg/L
Total Dissolved Solids	E	270	mg/L
Total Kjeldahl Nitrogen as N	E	0.7	mg/L
Total Organic Carbon	E	5.9	mg/L
Total Phosphate as P	E	0.11	mg/L
Total Suspended Solids	E	33	mg/L
Total Volatile Suspended Solids	E	7	mg/L
Triclopyr	E	0.21	ug/L
Turbidity	E	18	NTU
E = Event Composite Sample G = Grab Sample			

Table 2-8D Storm Event Sampling Site DRC 1

Result Analyte	Type	Concentration	Unit
DRC 1 5/30/2007			
Ammonia Nitrogen as N	E	<0.05	mg/L
Chloride	E	29	mg/L
Chlorophyll A	E	1	ug/L
Dissolved Inorganic Carbon	E	47	mg/L
Dissolved Organic Carbon	E	1	mg/L
Dissolved Oxygen	G	8.6	mg/L
E.coli	E	1500	/100mL
Field pH	G	7.8	pH Units
Field Temperature	G	17.9	Degrees C
Flow Rate	G	37	cfs
Nitrate + Nitrite Nitrogen as N	E	6	mg/L
Ortho Phosphate as P	E	0.02	mg/L
Total Biochemical Oxygen Demand (5 day)	E	<2	mg/L
Total Dissolved Solids	E	340	mg/L
Total Kjeldahl Nitrogen as N	E	0.1	mg/L
Total Organic Carbon	E	1.6	mg/L
Total Suspended Solids	E	7	mg/L
Total Volatile Suspended Solids	E	1	mg/L
Turbidity	E	3	NTU
E = Event Composite Sample G = Grab Sample			

Table 2-8E Storm Event Sampling Site DRC 1

Result Analyte	Type	Concentration	Unit
DRC 1 5/24/2007			
2,4-D	E	2.7	ug/L
Acetochlor	E	0.44	ug/L
Atrazine	E	0.69	ug/L
bis(2-Ethylhexyl)phthalate	E	76	ug/L
Chloride	E	26	mg/L
Chlorophyll A	E	19	ug/L
Desethyl Atrazine	E	0.13	ug/L
Dimethenamid	E	0.077	ug/L
Dissolved Inorganic Carbon	E	29	mg/L
Dissolved Organic Carbon	E	4.7	mg/L
Dissolved Oxygen	G	9.2	mg/L
E.coli	E	85000	/100mL
E.coli	G	9600	/100mL
Field pH	G	7.6	pH Units
Field Temperature	G	17.1	Degrees C
Flow Rate	G	35	cfs
Metolachlor	E	0.17	ug/L
Nitrate + Nitrite Nitrogen as N	E	3.9	mg/L
Ortho Phosphate as P	E	0.04	mg/L
Total Biochemical Oxygen Demand (5 day)	E	7	mg/L
Total Copper	E	0.02	mg/L
Total Dissolved Solids	E	240	mg/L
Total Kjeldahl Nitrogen as N	E	2.3	mg/L
Total Organic Carbon	E	24	mg/L
Total Phosphate as P	E	0.39	mg/L
Total Suspended Solids	E	240	mg/L
Total Volatile Suspended Solids	E	38	mg/L
Total Zinc	E	0.03	mg/L
Turbidity	E	140	NTU
E = Event Composite Sample G = Grab Sample			

Table 2-8F Storm Event Sampling Site DRC 1

Result Analyte	Type	Concentration	Unit
DRC 1 6/17/2007			
Acetone	E	12	ug/L
Atrazine	E	0.22	ug/L
bis(2-Ethylhexyl)phthalate	E	28	ug/L
Chloride	E	27	mg/L
Chlorophyll A	E	2	ug/L
Desethyl Atrazine	E	0.15	ug/L
Dissolved Inorganic Carbon	E	41	mg/L
Dissolved Organic Carbon	E	4.4	mg/L
Dissolved Oxygen	G	9.4	mg/L
E.coli	E	15000	/100mL
E.coli	G	880	/100mL
Field pH	G	7.8	pH Units
Field Temperature	G	20.4	Degrees C
Flow Rate	G	37	cfs
Nitrate + Nitrite Nitrogen as N	E	4.4	mg/L
Total Biochemical Oxygen Demand (5 day)	E	11	mg/L
Total Dissolved Solids	E	300	mg/L
Total Kjeldahl Nitrogen as N	E	0.8	mg/L
Total Organic Carbon	E	6.5	mg/L
Total Phosphate as P	E	0.07	mg/L
Total Suspended Solids	E	27	mg/L
Total Volatile Suspended Solids	E	8	mg/L
Turbidity	E	6.4	NTU
E = Event Composite Sample G = Grab Sample			

Table 2-8G Storm Event Sampling Site DRC 1

Result Analyte	Type	Concentration	Unit
DRC 1 6/27/2007			
Ammonia Nitrogen as N	E	<0.05	mg/L
Chloride	E	28	mg/L
Chlorophyll A	E	<1	ug/L
Dissolved Inorganic Carbon	E	46	mg/L
Dissolved Organic Carbon	E	0.7	mg/L
Dissolved Oxygen	G	9.4	mg/L
E.coli	E	710	/100mL
Field pH	G	8	pH Units
Field Temperature	G	19.6	Degrees C
Flow Rate	G	39	cfs
Nitrate + Nitrite Nitrogen as N	E	5.1	mg/L
Ortho Phosphate as P	E	0.02	mg/L
Total Biochemical Oxygen Demand (5 day)	E	<2	mg/L
Total Dissolved Solids	E	340	mg/L
Total Kjeldahl Nitrogen as N	E	0.2	mg/L
Total Organic Carbon	E	1.7	mg/L
Total Phosphate as P	E	0.05	mg/L
Total Suspended Solids	E	15	mg/L
Total Volatile Suspended Solids	E	3	mg/L
Turbidity	E	5.8	NTU
E = Event Composite Sample G = Grab Sample			

Table 2-8H Storm Event Sampling Site DRC 1

Result Analyte	Type	Concentration	Unit
DRC 1 7/17/2007			
Ammonia Nitrogen as N	E	<0.05	mg/L
Chloride	E	23	mg/L
Chlorophyll A	E	4	ug/L
Dissolved Inorganic Carbon	E	31	mg/L
Dissolved Organic Carbon	E	4.4	mg/L
E.coli	E	27000	/100mL
E.coli	G	4500	/100mL
Nitrate + Nitrite Nitrogen as N	E	1.6	mg/L
Ortho Phosphate as P	E	0.03	mg/L
Total Biochemical Oxygen Demand (5 day)	E	5	mg/L
Total Dissolved Solids	E	250	mg/L
Total Kjeldahl Nitrogen as N	E	1.2	mg/L
Total Organic Carbon	E	11	mg/L
Total Phosphate as P	E	0.22	mg/L
Total Suspended Solids	E	160	mg/L
Total Volatile Suspended Solids	E	23	mg/L
Turbidity	E	97	NTU
E = Event Composite Sample G = Grab Sample			

Table 2-8I Storm Event Sampling Site DRC 1

Result Analyte	Type	Concentration	Unit
DRC 1 8/5/2007			
bis(2-Ethylhexyl)phthalate	E	34	ug/L
Chloride	E	23	mg/L
Chlorophyll A	E	7	ug/L
Chlorpyrifos	E	0.05	ug/L
Dissolved Inorganic Carbon	E	36	mg/L
Dissolved Organic Carbon	E	2.8	mg/L
E.coli	G	2300	/100mL
E.coli	E	4200	/100mL
Nitrate + Nitrite Nitrogen as N	E	1.8	mg/L
Ortho Phosphate as P	E	0.04	mg/L
Prometon	E	0.06	ug/L
Tetrachloroethene	E	8	ug/L
Total Biochemical Oxygen Demand (5 day)	E	4	mg/L
Total Dissolved Solids	E	250	mg/L
Total Kjeldahl Nitrogen as N	E	0.8	mg/L
Total Organic Carbon	E	7.8	mg/L
Total Phosphate as P	E	0.14	mg/L
Total Suspended Solids	E	97	mg/L
Total Volatile Suspended Solids	E	16	mg/L
Turbidity	E	68	NTU
E = Event Composite Sample G = Grab Sample			

Table 2-8J Storm Event Sampling Site DRC 1

Result Analyte	Type	Concentration	Unit
DRC 1 9/8/2007			
Ammonia Nitrogen as N	E	0.05	mg/L
Chloride	E	23	mg/L
Chlorophyll A	E	7	ug/L
Dissolved Inorganic Carbon	E	38	mg/L
Dissolved Organic Carbon	E	2.6	mg/L
E.coli	E	18000	/100mL
E.coli	G	860	/100mL
Nitrate + Nitrite Nitrogen as N	E	2.4	mg/L
Ortho Phosphate as P	E	0.04	mg/L
Total Biochemical Oxygen Demand (5 day)	E	4	mg/L
Total Dissolved Solids	E	280	mg/L
Total Kjeldahl Nitrogen as N	E	0.6	mg/L
Total Organic Carbon	E	8	mg/L
Total Phosphate as P	E	0.22	mg/L
Total Suspended Solids	E	150	mg/L
Total Volatile Suspended Solids	E	24	mg/L
Turbidity	E	73	NTU
E = Event Composite Sample G = Grab Sample			

Table 2-9 Storm Event Sampling Site DRC 4

Result Analyte	Type	Concentration	Unit
DRC 4 7/27/2006			
Ammonia Nitrogen as N	E	<0.05	mg/L
Chloride	E	22	mg/L
Chlorophyll A	E	16	ug/L
Dissolved Inorganic Carbon	E	33	mg/L
Dissolved Organic Carbon	E	4	mg/L
Dissolved Oxygen	G	9.2	mg/L
E.coli	G	940	/100mL
E.coli	E	3000	/100mL
Field pH	G	7.8	pH Units
Field Temperature	G	18.6	Degrees C
Nitrate + Nitrite Nitrogen as N	E	3.5	mg/L
Ortho Phosphate as P	E	0.1	mg/L
Total Biochemical Oxygen Demand (5 day)	E	5	mg/L
Total Dissolved Solids	E	270	mg/L
Total Kjeldahl Nitrogen as N	E	1.5	mg/L
Total Organic Carbon	E	13	mg/L
Total Phosphate as P	E	0.32	mg/L
Total Suspended Solids	E	180	mg/L
Total Volatile Suspended Solids	E	30	mg/L
Turbidity	E	120	NTU
E = Event Composite Sample G = Grab Sample			

Table 2-9B Storm Event Sampling Site DRC 4

Result Analyte	Type	Concentration	Unit
DRC 4 9/11/2006			
Ammonia Nitrogen as N	E	0.1	mg/L
Chloride	E	14	mg/L
Chlorophyll A	E	7	ug/L
Dissolved Inorganic Carbon	E	18	mg/L
Dissolved Organic Carbon	E	4.5	mg/L
Nitrate + Nitrite Nitrogen as N	E	1.2	mg/L
Ortho Phosphate as P	E	0.05	mg/L
Total Biochemical Oxygen Demand (5 day)	E	9	mg/L
Total Dissolved Solids	E	170	mg/L
Total Kjeldahl Nitrogen as N	E	1.1	mg/L
Total Organic Carbon	E	14	mg/L
Total Phosphate as P	E	0.31	mg/L
Total Suspended Solids	E	210	mg/L
Total Volatile Suspended Solids	E	42	mg/L
Turbidity	E	110	NTU
E = Event Composite Sample G = Grab Sample			

Table 2-9C Storm Event Sampling Site DRC 4

Result Analyte	Type	Result Value	Units
DRC 4 5/31/2007			
Ammonia Nitrogen as N	E	<0.05	mg/L
Chloride	E	26	mg/L
Chlorophyll A	E	7	ug/L
Dissolved Inorganic Carbon	E	34	mg/L
Dissolved Organic Carbon	E	3	mg/L
Dissolved Oxygen	G	8.6	mg/L
E.coli	E	3500	/100mL
E.coli	G	860	/100mL
Field pH	G	7.6	pH Units
Field Temperature	G	18.1	Degrees C
Flow Rate	G	40	cfs
Nitrate + Nitrite Nitrogen as N	E	8	mg/L
Ortho Phosphate as P	E	0.02	mg/L
Total Biochemical Oxygen Demand (5 day)	E	<2	mg/L
Total Dissolved Solids	E	320	mg/L
Total Kjeldahl Nitrogen as N	E	0.8	mg/L
Total Organic Carbon	E	8.8	mg/L
Total Phosphate as P	E	0.2	mg/L
Total Suspended Solids	E	110	mg/L
Total Volatile Suspended Solids	E	16	mg/L
Turbidity	E	96	NTU
E = Event Composite Sample G = Grab Sample			

Table 2-9C Storm Event Sampling Site DRC 4

Result Analyte	Type	Result Value	Units
DRC 4 5/23/2007			
2,4-D	E	1.6	ug/L
Acetochlor	E	0.82	ug/L
Ammonia Nitrogen as N	E	0.14	mg/L
Atrazine	E	0.82	ug/L
bis(2-Ethylhexyl)phthalate	E	60	ug/L
Bromacil	E	0.094	ug/L
Chloride	E	26	mg/L
Chlorophyll A	E	6	ug/L
Desethyl Atrazine	E	0.12	ug/L
Desisopropyl Atrazine	E	0.065	ug/L
Dimethenamid	E	0.087	ug/L
Dissolved Inorganic Carbon	E	35	mg/L
Dissolved Organic Carbon	E	3.2	mg/L
Dissolved Oxygen	G	8.7	mg/L
E.coli	G	2300	/100mL
E.coli	E	2600	/100mL
Field pH	G	7.4	pH Units
Field Temperature	G	16.5	Degrees C
Flow Rate	G	11	cfs
Metolachlor	E	0.11	ug/L
Nitrate + Nitrite Nitrogen as N	E	5.3	mg/L
Ortho Phosphate as P	E	0.03	mg/L
Total Beryllium	E	0.02	mg/L
Total Biochemical Oxygen Demand (5 day)	E	12	mg/L
Total Chromium	E	0.02	mg/L
Total Copper	E	0.01	mg/L
Total Dissolved Solids	E	300	mg/L
Total Kjeldahl Nitrogen as N	E	0.9	mg/L
Total Organic Carbon	E	11	mg/L
Total Phosphate as P	E	0.23	mg/L
Total Suspended Solids	E	230	mg/L
Total Volatile Suspended Solids	E	40	mg/L
Total Zinc	E	0.02	mg/L
Turbidity	E	180	NTU
E = Event Composite Sample G = Grab Sample			

Table 2-9D Storm Event Sampling Site DRC 4

Result Analyte	Type	Result Value	Units
DRC 4 6/19/2007			
Atrazine	E	0.39	ug/L
bis(2-Ethylhexyl)phthalate	E	54	ug/L
Chloride	E	29	mg/L
Chlorophyll A	E	1	ug/L
Desethyl Atrazine	E	0.082	ug/L
Desisopropyl Atrazine	E	0.081	ug/L
Dissolved Inorganic Carbon	E	45	mg/L
Dissolved Organic Carbon	E	2.8	mg/L
Dissolved Oxygen	G	8	mg/L
E.coli	E	2200	/100mL
E.coli	G	530	/100mL
Field pH	G	7.6	pH Units
Field Temperature	G	18.9	Degrees C
Flow Rate	G	19	cfs
Nitrate + Nitrite Nitrogen as N	E	4.9	mg/L
Ortho Phosphate as P	E	0.03	mg/L
Total Biochemical Oxygen Demand (5 day)	E	2	mg/L
Total Copper	E	0.01	mg/L
Total Dissolved Solids	E	320	mg/L
Total Kjeldahl Nitrogen as N	E	0.6	mg/L
Total Organic Carbon	E	3.8	mg/L
Total Phosphate as P	E	0.07	mg/L
Total Suspended Solids	E	37	mg/L
Total Volatile Suspended Solids	E	6	mg/L
Turbidity	E	14	NTU
E = Event Composite Sample G = Grab Sample			

Table 2-9E Storm Event Sampling Site DRC 4

Result Analyte	Type	Result Value	Units
DRC 4 7/17/2007			
Ammonia Nitrogen as N	E	<0.05	mg/L
Chloride	E	27	mg/L
Chlorophyll A	E	5	ug/L
Dissolved Inorganic Carbon	E	41	mg/L
Dissolved Organic Carbon	E	1.7	mg/L
E.coli	E	3800	/100mL
E.coli	G	3200	/100mL
Nitrate + Nitrite Nitrogen as N	E	2.5	mg/L
Ortho Phosphate as P	E	0.03	mg/L
Total Biochemical Oxygen Demand (5 day)	E	<2	mg/L
Total Dissolved Solids	E	290	mg/L
Total Kjeldahl Nitrogen as N	E	0.8	mg/L
Total Organic Carbon	E	8.2	mg/L
Total Phosphate as P	E	0.12	mg/L
Total Suspended Solids	E	130	mg/L
Total Volatile Suspended Solids	E	22	mg/L
Turbidity	E	48	NTU
E = Event Composite Sample G = Grab Sample			

Table 2-9F Storm Event Sampling Site DRC 4

Result Analyte	Type	Result Value	Units
DRC 4 9/8/2007			
bis(2-Ethylhexyl)phthalate	E	67	ug/L
Chloride	E	26	mg/L
Chlorophyll A	E	2	ug/L
Dissolved Inorganic Carbon	E	42	mg/L
Dissolved Organic Carbon	E	2.2	mg/L
E.coli	G	500	/100mL
E.coli	E	3500	/100mL
Nitrate + Nitrite Nitrogen as N	E	3	mg/L
Ortho Phosphate as P	E	0.02	mg/L
Pentachlorophenol	E	0.51	ug/L
Total Biochemical Oxygen Demand (5 day)	E	3	mg/L
Total Copper	E	0.02	mg/L
Total Dissolved Solids	E	300	mg/L
Total Kjeldahl Nitrogen as N	E	0.4	mg/L
Total Organic Carbon	E	4.8	mg/L
Total Phosphate as P	E	0.1	mg/L
Total Suspended Solids	E	49	mg/L
Total Volatile Suspended Solids	E	10	mg/L
Turbidity	E	24	NTU
E = Event Composite Sample G = Grab Sample			

Table 2-9G Storm Event Sampling Site DRC 4

Result Analyte	Type	Result Value	Units
DRC 4 9/30/2007 Post			
Ammonia Nitrogen as N	E	<0.05	mg/L
Chloride	E	32	mg/L
Chlorophyll A	E	2	ug/L
Dissolved Inorganic Carbon	E	48	mg/L
Dissolved Organic Carbon	E	1.4	mg/L
E.coli	E	2000	/100ml
Nitrate + Nitrite Nitrogen as N	E	3	mg/L
Ortho Phosphate as P	E	0.03	mg/L
Total Biochemical Oxygen Demand (5 day)	E	<2	mg/L
Total Dissolved Solids	E	310	mg/L
Total Kjeldahl Nitrogen as N	E	0.2	mg/L
Total Organic Carbon	E	2.1	mg/L
Total Phosphate as P	E	0.04	mg/L
Total Suspended Solids	E	12	mg/L
Total Volatile Suspended Solids	E	3	mg/L
E.coli	G	520	/100mL
Field pH	G	7.7	pH Units
Field Temperature	G	17.7	Degrees C
Flow Rate	G	21	cfs
Dissolved Oxygen	G	8.5	mg/L
Turbidity	E	5.8	NTU
E = Event Composite Sample G = Grab Sample			

Table 2-9H Storm Event Sampling Site DRC 4

Result Analyte	Type	Result Value	Units
DRC 4 9/30/2007 Post			
Ammonia Nitrogen as N	E	<0.05	mg/L
Chloride	E	24	mg/L
Chlorophyll A	E	6	ug/L
Dissolved Inorganic Carbon	E	35	mg/L
Dissolved Organic Carbon	E	3.8	mg/L
E.coli	E	4900	/100ml
Nitrate + Nitrite Nitrogen as N	E	2.2	mg/L
Ortho Phosphate as P	E	0.02	mg/L
Total Biochemical Oxygen Demand (5 day)	E	7	mg/L
Total Dissolved Solids	E	240	mg/L
Total Kjeldahl Nitrogen as N	E	0.4	mg/L
Total Organic Carbon	E	6.4	mg/L
Total Phosphate as P	E	0.08	mg/L
Total Suspended Solids	E	49	mg/L
Total Volatile Suspended Solids	E	9	mg/L
E.coli	G	520	/100mL
Field pH	G	7.7	pH Units
Field Temperature	G	17.7	Degrees C
Flow Rate	G	21	cfs
Dissolved Oxygen	G	8.5	mg/L
Turbidity	E	20	NTU
E = Event Composite Sample G = Grab Sample			

Table 2-9J Storm Event Sampling Site DRC 4

Result Analyte	Type	Result Value	Units
DRC 4 4/19/2008			
Acetochlor	E	9	ug/L
Ammonia Nitrogen as N	E	0.28	mg/L
Atrazine	E	4.4	ug/L
bis(2-Ethylhexyl)phthalate	E	61	ug/L
Chloride	E	14	mg/L
Chlorophyll A	E	14	ug/L
Desethyl Atrazine	E	0.068	ug/L
Desisopropyl Atrazine	E	0.068	ug/L
Dissolved Inorganic Carbon	E	21	mg/L
Dissolved Organic Carbon	E	5.2	mg/L
Dissolved Oxygen	G	11.6	mg/L
E.coli	G	130	/100mL
E.coli	E	320	/100mL
Field pH	G	8.1	pH Units
Field Temperature	G	7.3	Degrees C
Flow Rate	G	36	cfs
Nitrate + Nitrite Nitrogen as N	E	5.4	mg/L
Ortho Phosphate as P	E	0.33	mg/L
Total Biochemical Oxygen Demand (5 day)	E	5	mg/L
Total Copper	E	0.02	mg/L
Total Dissolved Solids	E	200	mg/L
Total Kjeldahl Nitrogen as N	E	2.7	mg/L
Total Organic Carbon	E	23	mg/L
Total Phosphate as P	E	0.85	mg/L
Total Suspended Solids	E	810	mg/L
Total Volatile Suspended Solids	E	110	mg/L
Total Zinc	E	0.05	mg/L
Turbidity	E	250	NTU
E = Event Composite Sample G = Grab Sample			

Table 2-10 Sediment Sampling

Result Analyte	Result Value	Units
DRC 1 5/30/2007		
Total Nickel	11	mg/kg by dry wt
Total Chromium	15	mg/kg by dry wt
Total Lead	18	mg/kg by dry wt
Total Zinc	62	mg/kg by dry wt
Total Arsenic	2.4	mg/kg by dry wt
Total Copper	14	mg/kg by dry wt
Ammonia Nitrogen as N	27	mg/kg by dry wt
Total Solids	50.64	% by dry wt
Bromacil	0.01	mg/kg by dry wt
Pendimethalin	0.016	mg/kg by dry wt

Table 2-10B Sediment Sampling

Result Analyte	Result Value	Units
DRC 1 6/27/2007		
Total Nickel	5.7	mg/kg by dry wt
Total Chromium	9.9	mg/kg by dry wt
Total Lead	12	mg/kg by dry wt
Total Zinc	44	mg/kg by dry wt
Total Arsenic	1.7	mg/kg by dry wt
Total Copper	10	mg/kg by dry wt
Fluoranthene	280	ug/kg
Pyrene	510	ug/kg

Table 2-10C Sediment Sampling

Result Analyte	Result Value	Units
DRC 4 5/30/2007		
Total Nickel	13	mg/kg by dry wt
Total Chromium	18	mg/kg by dry wt
Total Lead	15	mg/kg by dry wt
Total Zinc	71	mg/kg by dry wt
Total Arsenic	2.7	mg/kg by dry wt
Total Copper	27	mg/kg by dry wt
Ammonia Nitrogen as N	19	mg/kg by dry wt
Total Solids	47.99	% by dry wt
Pyrene	940	ug/kg
Benzo(b)fluoranthene	580	ug/kg

Table 2-10D Sediment Sampling

Result Analyte	Result Value	Units
DRC 4 6/27/2007		
Total Nickel	12	mg/kg by dry wt
Total Chromium	19	mg/kg by dry wt
Total Lead	15	mg/kg by dry wt
Total Zinc	76	mg/kg by dry wt
Total Arsenic	2.9	mg/kg by dry wt
Total Copper	29	mg/kg by dry wt
Atrazine	0.011	mg/kg by dry wt
Total Solids	45.05	% by dry wt
Pyrene	340	ug/kg

Table 2-11 Storm Water and Sediment Chemical Sampling

Stormevent Water Samples				Sediment Samples		
Result Analyte	Type/source of Chem	Site Found		Result Analyte	Type/source of Chem	Found
2,4-D	Herbicide	1 & 4		Atrazine	Herbicide	4
Acetochlor	Herbicide	1 & 4		Benzo(b)fluoranthene	combustion effluents/ PAH	4
Acetone	plastic/fiber production	1		Bromacil	Herbicide	1
Atrazine	Herbicide	1 & 4		Fluoranthene	Combustion/ EPA priority pollutant PAH	1
bis(2-Ethylhexyl)phthalate	Plasticizer/PVC pipes	1 & 4		Pendimethalin	Herbicide	1
Bromacil	Herbicide	4		Pyrene	Coal Tar	1 & 4
Bromoxynil	Herbicide	1		Total Arsenic	pesticide/herbicide	1 & 4
Chloride		1 & 4		Total Chromium	electro plating/textiles	1 & 4
Chlorpyrifos	Insecticide	1		Total Copper		1 & 4
Desethyl Atrazine	Herbicide	1 & 4		Total Lead		1 & 4
Desisopropyl Atrazine	Herbicide	4		Total Nickel		1 & 4
Dimethenamid	Pesticide	1 & 4		Total Zinc		1 & 4
Metolachlor	Herbicide	1 & 4				
Pentachlorophenol	Pesticide	4				
Prometon	Herbicide	1				
Tetrachloroethene	Drycleaning/de-greasing	1				
Total Beryllium	metal, silicone chips, x ray windows, electronic industries	4				
Total Chromium	electro plating/textiles	4				
Total Copper		1 & 4				
Total Zinc		1 & 4				
Triclopyr	Herbicide	1				

Table 2-12 MS4 Storm Sewer Water Quality Sampling

	Cadmium		Chromium		Copper		Iron		Lead		Zinc		Oil and Grease		Coli form, Fecal		$CBOD_5$		TSS	
	mg/l		mg/l		mg/l		mg/l		mg/l		mg/l		mg/l		mg/l		mg/l		mg/l	
Date	Com.	Res.	Com.	Res.	Com.	Res.	Com.	Res.	Com.	Res.	Com.	Res.	Com.	Res.	Com.	Res.	Com.	Res.	Com.	Res.
18-May-05	<0.02	<0.02	<0.02	<0.02	0.02	0.028	8.01	5.45	<0.1	<0.1	0.158	0.241	<5.0	<5.0	20K	98K	13	36	480	900
20-Jul-05	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	12.5	6.49	<0.1	<0.1	0.349	0.088	<5.0	<5.0	535	38.5K	20	16	452	260
15-Nov-05	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.186	0.822	<0.1	<0.1	<0.02	0.0555	<5.0	<5.28	890	5.8K	8	27	2	10
25-May-06	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.836	0.529	<0.1	<0.1	0.0743	0.154	<5.16	<5.0	1500	17K	3.3	7.2	33.5	20.7
1-Aug-06	<0.02	<0.02	<0.02	<0.02	<0.02	0.0294	2.32	5.79	<0.1	<0.1	0.0558	0.445	<4.85	<5.28	13K	198K	6.3	28.5	65.0	303
20-Dec-06	<0.02	<0.02	<0.02	0.0315	<0.02	0.0534	0.28	19.4	<0.1	<0.1	0.0421	0.518	<4.8	12.2	220	3K	4.2	34	10.2	633
23-May-07	<0.02	<0.02	<0.02	0.0341	<0.02	0.071	11.3	15.3	<0.1	<0.1	0.192	0.789	<4.9	29.3	130K	28K	9.5	120	288	660
15-Aug-07	<0.02	<0.02	<0.02	<0.02	0.0512	0.0242	19.4	0.361	<0.1	<0.1	0.202	0.0576	<5.0	NR	2350	51K	17.1	16.2	808	44.5

Table 2-13 A TMDL Melt Water Sampling

Melt water sampling 3/2/2008										
Site	**Temp**	**DO**	**pH**	**Specific Conductance**	**Turbidity (NTU)**	**Flow**	**BOD5**	**TSS**	**Chloride**	**Ammonia**
DRC 1	0.2	16.17	8.5	934	255	50.55	8	160	430	0.37
DRC 2	0.2	14.93	8.6	961	208		9	120	450	0.41
DRC 3	0.3	14.66	8.6	797	284		10	240	360	0.44
DRC 4	4.7	13.67	8.9	811	66	5.63	2	56	190	0.06
DRC 5	1.2	12.76	8.7	1209	188	9.13	8	150	470	0.4
DRC 6	3.4	12.92	8.4	510	10	0.78	<2	10	100	<0.05
DRC 7	1.6	12.95	8.9	329	18		<2	34	17	<0.05
DRC 8	1.7	14.09	8.6	872	149		8	150	340	0.27
DRC 9	2.3	14.9	8.9	360	9		<2	8	29	<0.05
DRC 10	2.5	15.66	9.3	630	7		<2	5	160	0.1
OF 2	5.7	12.95	8.7	549	105	1.1	5	100	210	0.34
OF 3	2.4	13.89	8.6	712	198		10	130	330	0.62
OF 4	2.4	14.87	8.6	1055	273	6.85	11	220	560	0.67
OF 6	3	14.12	8.5	704	5		3	6	190	<.05
OF 7	2.1	14.57	9.3	1097	70	0.11	3	56	400	0.2
OF2a	2.3	13.54	8.6	1545	37	0.1	24	34	800	0.45

Table 2-13 B TMDL Melt Water Sampling

Melt water sampling 3/13/2008										
Site	Temp	DO	pH	Specific Conductance	Turbidity (NTU)	Flow	BOD5	TSS	Chloride	Ammonia
DRC 1	1.5	14.2	8.3	281	87	136.59	19	140	78	0.81
DRC 2	0.2	12.66	8.4	287	257		>21	320		0.82
DRC 3	2	13.1	8.3	277	19		>21	190	76	0.62
DRC 4	1.5	13.4	8.2	195	92	52.14	20	160	23	0.8
DRC 5	1.3	12.9	8.4	260	146	83.54	>22	280	96	0.85
DRC 6	0.5	14.1	8.1	167	74		14	63	14	0.51
DRC 7	0.9	13.4	8.5	133	10		>23	29	7	0.91
DRC 8	1.8	12.2	8.5	296	159		19	310	88	0.84
DRC 9	0.2	12.9	8.6	120	22		>22	28	12	1
DRC 10	0.4	9.63	9	210	41		>21	77	51	1
OF 2	4.1	12.6	8.4	1208	170	0.02	16	89	630	0.53
OF 3	4.4	11.8	8.5	480	195		15	120	250	0.67
OF 4	3.6	12.9	8.4	357	110	6.6	>21	120	120	0.97
OF 5	1.3	12.45	8.9	222	14	0.044	6	9	43	0.33
OF 6	1.9	13	8.2	423	8		13	10	130	0.37
OF2a	2.6	12.4	8.6	130	40	0.0133	12	26	390	0.21

Table 2-14 TMDL Melt Water Sampling

Melt water sampling 12/28/2005				
Site	**Temp ºC**	**DO mg/L**	**Chlorine ppm (Total, Free)**	**Chloride ppm**
DRC 1	1	14		282
DRC 2				
DRC 3	1	14		262
DRC 4	6	10		123
DRC 4 (storm drain)			(1.38, 1.24)	
DRC 5 U	1	13		375
DRC 5 D	1	13		403
DRC 6	4	11		64
DRC 7	6	12		31
DRC 8	1	15		375
DRC 9	1	14		<31
DRC 10	2	12		375
Site 5 U & D taken up and downstream of University avenue bridge				

Table 2-15 Mobile home discharge and ammonia/TKN levels at DRC 6

DRC 6 Sample Date	Ammonia (mg/L)	TKN	Cedar Falls Mobile Home Village discharge (Yes/No)
6/9/2005	0.05	0.52	No
6/16/2005	< 0.05	0.62	No
6/23/2005	< 0.05	1	No
6/30/2005	< 0.05	0.38	No
7/7/2005	< 0.05	0.46	No
7/14/2005	< 0.05	0.3	No
7/21/2005	< 0.05	0.59	No
7/28/2005	< 0.05	0.74	No
8/4/2005	< 0.05	1.9	No
8/11/2005	< 0.05	0.71	No
8/18/2005	< 0.05	0.7	No
8/25/2005	< 0.05	1.1	No
9/1/2005	< 0.05	2.2	No
9/8/2005	-	-	No
9/15/2005	-	-	No
9/22/2005	-	-	No
10/5/2005	0.32	46	Yes
10/20/2005	2	4.5	Yes
11/2/2005	< 0.05	15	No
11/21/2005	< 0.05	6.2	No
12/28/2005	< 0.05	0.3	No
3/9/2006	0.080	1.2	No
4/12/2006	0.840	1.9	Yes
4/26/2006	< 0.05	0.6	Yes
5/2/2006	< 0.05	0.9	No
5/24/2006	< 0.05	0.4	No
6/8/2006	< 0.05	0.6	No
6/15/2006	< 0.05	0.5	No
6/20/2006	< 0.05	0.9	No
7/5/2006	< 0.05	0.4	No
7/18/2006	< 0.05	0.5	No
8/1/2006	< 0.05	0.5	No
8/15/2006	< 0.05	0.4	No
8/29/2006	< 0.05	0.2	No
9/12/2006	< 0.05	0.3	No
9/26/2006	< 0.05	0.3	No
10/10/2006	< 0.05	0.3	Yes
10/24/2006	1.700	4.2	Yes
11/7/2006	< 0.05	0.3	No
12/5/2006	< 0.05	0.3	No

Table 2-15B Mobile home discharge and ammonia/TKN levels at DRC 6

DRC 6 Sample Date	Ammonia (mg/L)	TKN	Cedar Falls Mobile Home Village discharge (Yes/No)
1/11/2007	< 0.05	0.3	No
2/15/2007	< 0.05	0.2	No
3/6/2007	< 0.05	0.3	No
3/20/2007	0.08	0.4	No
4/3/2007	< 0.05	1.7	Yes
4/17/2007	0.4	1.2	Yes
5/1/2007	< 0.05	0.2	No
5/15/2007	< 0.05	0.3	No
5/30/2007	< 0.05	0.3	No
6/13/2007	< 0.05	0.3	No
6/27/2007	< 0.05	0.5	No
7/11/2007	< 0.05	0.5	No
7/23/2007	< 0.05	1.6	No
8/8/2007	< 0.05	0.6	No
8/22/2007	< 0.05	0.8	No
9/5/2007	< 0.05	0.2	Yes
9/19/2007	< 0.05	1.2	Yes
10/3/2007	< 0.05	0.6	No
10/17/2007	< 0.05	0.4	No
11/8/2007	< 0.05	0.3	No
12/5/2007	< 0.05	0.2	No
1/9/2008	0.07	0.5	No
2/20/2008	< 0.05	0.4	No
3/11/2008	< 0.05	0.2	No
3/26/2008	0.07	0.3	No
4/9/2008	< 0.05	0.5	No
4/23/2008	< 0.05	0.4	No
5/8/2008	< 0.05	0.4	Yes
5/21/2008	< 0.05	0.2	Yes
6/4/2008	< 0.05	0.4	No

Table 2-16 UNI Ecotoxicological study: Outfall sampling

Site	Site Map Id	Date	Temp C	DO mg/l	Sal. Ppt.	pH	Cond. Us/cm	Hardness	Alkalinity
Control		5/17/2006	19.58	8.51	0.16	8.16	326	166	83
Roth Preserve	9		22	8.95	0.28	7.96	545	281	148
Univ./Hudson	1		21.73	8.15	0.67	7.74	1262	570	165
Lutheran S.	2		21.69	8.93	0.28	7.93	543	292	140
Univ. Bridge E.	7		21.62	9.31	0.24	7.86	481	251	143
Univ. Bridge W.	8		21.74	8.85	0.23	7.95	465	254	160
UNI Towers	6		21.76	8.54	0.31	7.74	612	272	172
Westminister 1	3		21.8	9.04	0.46	7.84	890	326	154
Dog Park	4		21.87	8.98	0.36	7.96	704	316	149
Uni Dome PL	5		21.96	8.63	0.2	8.02	406	234	157
Control		6/13/2006	19.88	8.65	0.17	8.2	343	202	148
Roth Preserve	9		20.74	8.83	0.27	7.93	534	292	213
Univ./Hudson	1		no flow	no flow	no flow	no flow	no flow	no flow	no flow
Univ. Bridge E.	7		20.86	8.63	0.32	8.03	623	316	212
Univ. Bridge W.	8		20.86	8.56	0.28	8.01	555	281	203
UNI Towers	6		20.94	8.5	0.32	7.94	620	316	206
Westminister 1	3		20.89	8.22	0.55	7.8	1050	457	212
Dog Park	4		20.74	8.45	0.36	7.68	665	341	207
Uni Dome PL	5		20.89	8.35	0.2	8.11	403	248	218
Control		6/22/2006	20.22	8.71	0.17	8.26	345	167	108
Roth Preserve	9		20.59	8.52	0.28	7.95	540	274	209
Cedar River			23.29	7.97	0.26	8.07	518	276	200
DRC 18th/main			21.29	8.93	0.23	8.02	453	247	211
Westminister 1	3		21.6	7.86	0.53	7.81	1007	359	215
Dog Park	4		21.52	8.72	0.34	7.91	668	322	213
Uni Dome PL	5		23.4	7.57	0.2	7.95	410	236	222
Control		7/12/2006	21.25	8.11	0.19	8.25	375	137	105
Roth Preserve	9		23.04	7.21	0.14	8.08	287	131	92
Univ./Hudson	1		23.06	7.26	0.12	8.07	260	82	52
Univ. Bridge E.	7		23.15	6.87	0.05	8.04	115	52	50
Univ. Bridge W.	8		23.05	5.87	0.08	8.11	171	64	71
UNI Towers	6		23.09	7.82	0.05	7.72	624	301	199
Westminister 1	3		23	7.35	0.1	8.08	213	76	80
Dog Park	4		23.18	6.88	0.07	7.94	164	69	53
Uni Dome PL	5		23.18	7.46	0.21	7.94	413	229	215

Table 2-16B UNI Ecotoxicological study: Outfall sampling

Site	Site Map Id	Date	Temp C	DO mg/l	Sal. Ppt.	pH	Cond. Us/cm	Hardness	Alkalinity
Control		8/8/2006	20.74	8.44	0.19	8.27	391	168	113
Dog Park	4		23.7	7.19	0.34	7.92	998	304	210
Westminister 1	3		24.09	7	0.55	7.81	1054	415	198
Univ./Hudson	1		25.49	7.24	0.23	7.91	464	231	192
Roth Preserve	9		23.57	7.98	0.28	7.85	551	295	221
Uni Dome PL	5		24.94	7.17	0.21	7.91	415	241	214
UNI Towers	6		27.3	6.81	0.26	7.81	521	265	218
Univ. Bridge E.	7		24.94	7.34	0.25	7.85	485	251	191
Univ. Bridge W.	8		23.56	7.96	0.28	7.87	547	277	213
Control		9/15/2006	20.04	8.02	0.18	8.52	371	188	119
Univ. Bridge E.	7		21.67	7.73	0.34	8.16	654	321	212
Univ. Bridge W.	8		21.76	7.63	0.33	8.27	634	317	198
Univ./Hudson	1		21.83	7.61	0.32	8.18	632	303	192
Westminister 1	3		21.76	7.86	0.33	8.13	643	272	155
Westminister 2	16		21.69	7.75	0.51	8.13	982	363	396
UNI Towers	6		21.94	7.74	0.42	8.14	817	351	204
Control		10/17/2006	17.06	7.37	0.18	8.35	357	157	90
New endergy C.	14		15.76	8.4	0.3	8.29	596	312	184
Univ./Hudson	1		19.15	7.54	0.24	8.06	476	262	187
Tennis C. NE	12		15.08	8.67	0.2	8.15	414	247	190
Tennis C. NW	13		16.06	8.4	0.21	8.21	423	243	197
UNI Towers	6		19.84	6.95	0.26	7.9	518	254	197
Univ. Bridge E.	7		17.2	7.79	0.27	8.06	533	281	194
Univ. Bridge W.	8		15.05	8.31	0.3	8.17	592	309	187
Tall Grass Prairie	15		14.69	8.66	0.3	8.02	589	316	197
Control		11/14/2006	17.54	7.73	0.15	8.44	307	136	107
Tall Grass Prairie	15		12.89	8.56	0.29	8.41	576	313	209
Tennis C. NE	12		10.34	9.12	0.38	8.25	736	334	171
Univ. Bridge W.	8		12.77	8.95	0.33	8.39	642	330	189
Panther Lane	11		14.07	8.48	0.25	8.19	496	260	120
Univ. Bridge E.	7		14.35	8.11	0.23	8.17	451	267	193
Univ./Hudson	1		14.12	8.3	0.26	8.12	509	264	193
UNI Towers	6		14.12	8.41	0.86	8.04	1633	533	231
MTLP	10		14.38	8.32	0.67	7.99	1269	512	215
Control		12/18/2006	18.56	8.42	0.19	8.58	380	215	177
Tall Grass Prairie	15		12.74	9.54	0.28	8.36	545	280	205
MTLP	10		10.61	10.21	1.01	8.19	1904	845	277
Panther Lane	11		9.92	10.84	0.24	8.33	480	252	127
Univ. Bridge E.	7		13.28	9.03	0.22	8.2	436	257	206
Campus Street	17		9.74	10.82	0.72	8.12	1357	490	197
Univ./Hudson	1		13.35	8.84	0.26	8.16	503	283	205

Table 2-16C UNI Ecotoxicological study: Outfall sampling

Site	Site Map Id	Date	Temp C	DO mg/l	Sal. Ppt.	pH	Cond. Us/cm	Hardness	Alkalinity
Control		1/17/2007	19.01	7.03	0.16	8.86	323	146	113
Campus St.	17		22.39	6.95	0.89	8.33	1668	502	193
Univ. Bridge E.	7		21.91	7.08	0.32	8.46	630	458	216
Univ./Hudson	1		21.32	6.94	0.24	8.48	468	255	196
MTLP	10		21.46	7.18	1.11	8.17	2076	717	288
Panther Lane	11		21.5	7.34	0.24	8.33	478	228	123
Tall Grass Prairie	15		21.5	7.1	0.29	8.27	578	277	205
Control		2/21/2007	21.42	7.15	0.16	8.82	336	151	110
UNI Towers	6		24.03	2.86	0.14	8.29	289	79	46
MTLP	10		23.58	6.12	2.9	8.21	5266	505	205
Univ. Bridge E.	7		23.46	6.59	0.39	8.38	746	314	212
Univ./Hudson	1		23.26	6.6	0.52	8.55	987	296	212
Campus St.	17		23.29	6.29	1.03	8.46	1932	217	92
Panther Lane	11		23.34	6.86	0.37	8.41	718	232	131
Tall Grass Prairie	15		23.39	6.93	0.29	8.61	563	263	204
Control		3/20/2007	19.22	6.75	0.17	7.6	338	145	103
Tall Grass Prairie	15		16.81	7.03	0.29	7.5	564	291	230
UNI Towers	6		13.51	7.81	0.91	7.47	1714	567	206
Panther Lane	11		13.85	7.89	0.22	7.46	441	231	118
MTLP	10		14.91	7.67	1.27	7.24	2366	802	266
Univ. Bridge E.	7		16.18	7.17	0.28	7.32	558	280	198
Westminister 3	18		14.94	7.86	0.58	7.35	1114	442	235
Univ./Hudson	1		16.36	7.2	0.38	7.29	726	366	215
Campus St.	17		15.34	7.82	0.84	7.41	1587	504	203
Westminister 1	3		16.38	7.64	0.62	7.38	1185	452	216
Control		4/19/2007	18.88	4.6	0.17	7.66	341	184	134
Uni Dome PL	5		21.8	4.19	0.21	7.65	423	239	221
Tall Grass Prairie	15		18.62	4.47	0.3	7.61	590	297	219
UNI Towers	6		17.36	4.72	1.03	7.41	1930	638	220
Campus St.	17		19.69	4.99	0.23	7.55	452	242	200
Univ./Hudson	1		19.55	4.38	0.32	7.46	630	306	217
Westminister 1	3		14.66	5.03	0.52	7.67	998	376	251
Roth	9		18.28	50.6	0.87	7.29	1640	548	292
Univ. Bridge E.	7		18.97	4.6	0.25	7.44	493	255	198
Panther Lane	11		12.65	5.49	0.22	7.67	444	214	127
Control		4/25/2007	19.43	4.12	0.16	7.93	329	147	109
Campus St.	17		13.67	4.65	0.21	7.85	429	235	209
Univ. Bridge W.	8		11.06	4.85	0.09	7.87	197	83	70
Roth	9		12.6	3.84	0.11	7.57	262	75	68
Westminister 1L	3		12.5	3.9	0.14	7.53	282	93	83
Westminister 1R	3		13.4	3.85	0.07	7.8	163	69	65
MTLP	10		12.5	3.92	0.17	7.58	343	131	103
Univ./Hudson	1		13	3.88	0.15	7.64	307	113	89
Panther Lane	11		12.6	3.93	0.08	7.62	180	85	67

Table 2-17 Ecotoxicological study: In-stream water quality

Site	Date	Temp C	DO mg/l	Sal. Ppt.	pH	Cond. Us/cm	Hardness	Alkalinity	Flow CFS
UHU	5/10/2006	12	9.46	0.29	7.93	576	400	145	4.758
UHD		12.23	9.85	0.3	7.76	573	321	116	2.292
Roth		13.18	9.22	0.26	7.75	535	291	151	32.388
UHU	6/7/2006	19.74	7.37	0.3	7.88	582	302	136	
UHD		20.25	8.21	0.3	7.99	586	311	132	
Roth		17.78	9.25	0.28	8.08	542	295	243	
CFU		19.4	9.35	0.28	8.44	521	289	212	
UHU	7/13/2006	19.83	6.33	0.3	8.02	579	316	189	
UHD		19.89	6.73	0.3	7.93	579	322	204	
Roth		18.34	8.1	0.28	7.88	549	285	207	
CFU		18.97	8.77	0.26	8.22	521	286	215	
UHU	8/9/2006	20.78	5.83	0.29	7.89	575	318	204	
UHD		21.29	5.84	0.29	7.93	565	281	202	
Roth		17.38	8.19	0.27	8.21	536	295	240	
CFU		20.73	7.86	0.18	8.39	359	194	148	
UHU	9/14/2006	15.57	8.41	0.31	7.89	598	273	197	
UHD		15.53	9.25	0.31	7.93	597	318	200	
Roth		14.96	8.38	0.28	7.94	552	253	193	
CFU		15.21	10.3	0.27	8.17	530	269	198	
Cedar R.		13.65	11.54	0.26	8.39	515	263	206	
UHU		12.47	11.68	0.32	7.92	625	342	199	
UHD		12.91	11.44	0.32	7.88	621	336	212	
Roth		12.89	12.64	0.29	7.98	561	278	208	
CFU		12.63	11.46	0.28	8.21	549	286	196	
Cedar R.	9/25/2006	14.37	9.55	0.27	8.25	528	301	236	
UHU		13.68	9.46	0.32	8.24	627	337	211	
UHD		13.53	9.5	0.32	8.42	624	320	212	
Roth		13.47	9.66	0.29	8.28	560	293	206	
CFU		12.59	9.69	0.28	8.39	544	287	205	
UHU	10/10/2006	11.51	9.02	0.31	7.95	598	310	194	
UHD		10.9	8.94	0.31	7.95	605	379	209	
Roth		12.33	9.65	0.28	7.97	551	279	212	
CFU		12.18	9.79	0.26	8.38	521	259	219	
UHU	11/7/2006	9.02	8.1	0.31	8.11	609	299	197	1.999
UHD		9.3	8.53	0.31	8.11	608	298	215	1.903
Roth		9.29	9.13	0.31	8.14	597	328	189	6.75
CFU		9.26	10.42	0.32	8.3	624	316	188	10.178

Table 2-17B Ecotoxicological study: In-stream water quality

Site	Date	Temp C	DO mg/l	Sal. Ppt.	pH	Cond. Us/cm	Hardness	Alkalinity	Flow CFS
UHU	12/13/2006	2.89	12.14	0.3	7.86	586	331	213	2.848
UHD		3.01	12.42	0.3	7.85	586	308	206	2.733
Roth		3.49	13.09	0.29	7.95	576	312	211	5.371
CFU		2.74	12.63	0.29	7.98	608	207	241	12.49
UHU	1/9/2007	2.74	12.7	0.3	8.05	587	342	198	2.789
UHD		2.74	13.02	0.3	8.05	587	376	224	3.399
Roth		2.2	12.91	0.29	8.18	572	321	213	9.369
CFU		1.49	12.33	0.31	8.13	599	207	239	14.306
UHD	2/14/2008	6.46	10.84	0.29	8.9	585	323	215	5.392
Roth		6.94	9.02	0.3	8.83	605	283	232	4.85
UHU	3/14/2008	7.14	9.74	0.22	9.12	435	234	166	20.695
UHD		7.54	9.22	0.22	9.16	432	257	154	43.183
Roth		7.88	8.78	0.22	8.95	434	202	130	65.252
UHU	4/10/2008	3.78	6.85	0.28	7.31	559	584	204	3.846
UHD		3.84	7.21	0.29	7.11	561	381	191	4.656
Roth		7.17	7.22	0.28	6.96	551	254	191	21.093
UHU	5/8/2008	11.06	5.03	0.28	8.03	550	301	187	6.064
UHD		11.32	5.35	0.28	7.8	553	293	192	9.647
Roth		13.14	4.92	0.27	7.72	540	261	189	37.05

Table 2-18 UNI Ecotoxicological study: Weekly min/max temperatures

Weekly Max/min. temperature readings from Dry Run Creek (ºC)								
Date	UHL		UHD		Roth		CFU	
	Max	Min	Max	Min	Max	Min	Max	Min
5/10/2006	15	11			16	13		
5/16/2006	20	10			16	13		
5/23/2006	20	10			15	10		
5/30/2006	29	14			20	15		
6/7/2006	23	16			19	15		
6/12/2006	24	9	28	9	18	13	37	12
6/21/2006	24	13	23	14	21	15	23	16
6/27/2006	23	16	23	15	19	16	23	16
7/13/2006	25	15	25	15	20	15	23	14
7/20/2006	28	19	27	19	22	17	28	17
7/26/2006	26	16	23	16	22	16		
8/1/2006	30	21	28	20	22	18		
8/8/2006	27	17	25	17	23	17	25	17
8/15/2006	22	17	22	19	20	17	22	17
8/22/2006	23	16	22	18	19	16	25	16
8/30/2006	25	16	26	16	19	16	26	16
9/7/2006	22	14	22	14	17	15	22	13
9/14/2006	20	13	20	15	17	16	20	14
9/19/2006	21	17	20	13	18	14	21	11
9/26/2006	14	7	14	11	16	13	17	13
10/3/2006	23	5	22	10	20	14	22	9
10/10/2006	23	10	24	5	20	13	25	10
10/17/2006	11	0	12	3	13	13	14	4
10/24/2006	14	2	14	2	13	4	14	4
10/31/2006	14	2	14	2	12	2	13	2
11/7/2006	10	-3	10	-3	10	-3	10	1
11/14/2006	17	0	15	-2	14	-3	20	1
11/23/2006	10	0	8	-1	9	0	13	0
11/30/2006	5	-2	5	-2	5	-1	7	0
12/8/2006	3	-3	5	-3	5	-4		
12/13/2006	6	-1	6	0	7	0	2	0
12/21/2006	10	4	8	2	8	4	15	4
12/29/2006	6	0	7	1	6	-2	12	-1

Table 2-18B UNI Ecotoxicological study: Weekly min/max temperatures

Weekly Max/min. temperature readings from Dry Run Creek (ºC)								
Date	UHL		UHD		Roth		CFU	
	Max	Min	Max	Min	Max	Min	Max	Min
1/5/2007	8	0	6	3	8	-3		
1/9/2007	6	0	7	-1	6	0	14	-1
1/25/2007	5	-1	5	-1	6	-5		
2/14/2006								
2/20/2006	9	-9	7	-6	4	-15		
3/1/2006	8	2	7	2	6	1		
3/8/2006	6	1	6	2	7	4	11	0
3/14/2006	9	0	8	1				
3/23/2006	14	2	11	5				
3/29/2006	22	3	18	4	20	8		
4/5/2006	14	2	12	1				
4/10/2006	8	4	10	2				
4/19/2006	19	1	15	5				
4/27/2006	21	7	17	6	21	9		
5/3/2006	24	9	17	10	17	10		
5/8/2006	19	10	23	12	15	10		

Table 2-19 FIBI metric breakdown

	Stream/Site Name			
	DRC 1	**DRC 1**	**DRC 4**	**47c Reference**
Sample Date	10/6/1999	10/3/2005	10/3/2005	
FIBI score	50	44	38	54
Native Species raw value	23	10	9	19.25
Native Species metric score	9.95	4.32	5.60	6.25
Sucker Species raw value	3	2	2	3.38
Sucker Species metric score	6.63	4.42	6.36	5.56
Sensitive Species raw value	4	2	2	4.17
Sensitive Species metric score	5.05	2.52	3.63	3.94
BINV Species raw value	6	2	3	6.33
BINV Species metric score	7.21	2.40	5.18	5.90
Pct Top3 Abundant raw value*	56.45	81.53	84.93	56.46*
Pct Top3 Abundant metric score	8.05	3.41	4	6.55
Pct BINV raw value	6.88	15.32	8.90	19.20
Pct BINV metric score	2.08	4.63	3.87	4.48
Pct Omnivore raw value*	31.81	3.15	26.71	22.52*
Pct Omnivore metric score	6.66	10	7.5	7.12
Pct Top Carnivore raw value	0.29	2.25	0	1.02
Pct Top Carnivore metric score	2.32	6.51	0	1.97
Pct Litho. Spawner raw value	1.15	1.58	0.68	2.43
Pct Litho. Spawner metric score	0.69	0.95	0.59	1.20
Tolerance Index raw value*	7.56	6.79	7.64	6.30*
Tolerance Index metric score	3.87	5.09	3.75	5.45
Adjusted CPUE raw value	19.98	41.88	8.31	27.41
Adjusted CPUE metric score	2.00	4.19	0.83	2.74
Pct DELT raw value	0	1.80	0.68	0.07

* Indicates the 75% was used in the comparison because higher scores = poorer conditions for these metrics.

Table 2-20 BMIBI metric breakdown

	Stream/Site Name			
	DRC 1	**DRC 1**	**DRC 4**	**47c Reference**
Date	10/6/1999	10/5/2005	10/3/2005	
BMIBI score	48	42	38	58
MH Total Taxa raw value	24	12	13	33
MH Total Taxa metric score	5.7	2.85	3.95	6.43
SH Total Taxa raw value	7.67	12	6.33	13.82
SH Total Taxa metric score	4.62	7.23	4.96	6.42
MH EPT Taxa raw value	10	4	4	16.38
MH EPT Taxa metric score	5.06	2.02	2.57	6.15
SH EPT Taxa raw value	4.33	5.67	4.33	9.40
SH EPT Taxa metric score	3.85	5.05	5.07	6.50
MH Sens Taxa raw value	2	0	0	5.75
MH Sens Taxa metric score	2.26	0	0	5.48
SH Ephem Pct raw value	44.14	1.56	0.89	22.08
SH Ephem Pct metric score	5.64	0.2	0.11	2.82
SH EPT Pct raw value	45.48	69.24	61.99	52.03
SH EPT Pct metric score	4.76	7.25	6.49	5.45
SH Chiron Pct raw value	8.86	17.08	36.79	23.19*
SH Chiron Pct metric score	9.21	8.38	6.39	7.76
SH Scraper Pct raw value	0.94	2.84	0	8.01
SH Scraper Pct metric score	0.21	0.64	0	1.79
SH 3Dom Pct raw value	87.33	71.61	83.23	73.23*
SH 3Dom Pct metric score	2.61	5.85	4.76	5.03
SH Dom FFG Pct raw value	64.29	67.16	65.56	60.26*
SH Dom FFG Pct metric score	5.95	5.47	5.74	6.62
MHBI raw value	4.88	5.41	5.52	5.28*
MHBI metric score	7.85	5.89	5.48	6.37

* Indicates the 75% was used in the comparison because higher scores = poorer conditions for these metrics.

Table 2-21 FIBI Metric Score Comparison Table

	DRC 1 10/6/1999		DRC 1 10/3/2005		DRC 4 10/3/2005		47c Ref. 25th %tile
FIBI score	50	93%	44	81%	38	70%	54
Native Species raw value	23		10		9		19.25
Native Species metric score	**9.95**	**159%**	**4.32**	**69%**	**5.6**	**90%**	**6.25**
Sucker Species raw value	3		2		2		3.38
Sucker Species metric score	**6.63**	**119%**	**4.42**	**79%**	**6.36**	**114%**	**5.56**
Sensitive Species raw value	4		2		2		4.17
Sensitive Species metric score	**5.05**	**128%**	**2.52**	**64%**	**3.63**	**92%**	**3.94**
BINV Species raw value	6		2		3		6.33
BINV Species metric score	**7.21**	**122%**	**2.4**	**41%**	**5.18**	**88%**	**5.9**
Pct Top3 Abundant raw value*	56.45		81.53		84.93		56.46
Pct Top3 Abundant metric score	**8.05**	**123%**	**3.41**	**52%**	**4**	**61%**	**6.55**
Pct BINV raw value	6.88		15.32		8.9		19.2
Pct BINV metric score	**2.08**	**46%**	**4.63**	**103%**	**3.87**	**86%**	**4.48**
Pct Omnivore raw value*	31.81		3.15		26.71		22.52
Pct Omnivore metric score	**6.66**	**94%**	**10**	**140%**	**7.5**	**105%**	**7.12**
Pct Top Carnivore raw value	0.29		2.25		0		1.02
Pct Top Carnivore metric score	**2.32**	**118%**	**6.51**	**330%**	**0**	**0%**	**1.97**
Pct Litho. Spawner raw value	1.15		1.58		0.68		2.43
Pct Litho. Spawner metric score	**0.69**	**58%**	**0.95**	**79%**	**0.59**	**49%**	**1.2**
Tolerance Index raw value*	7.56		6.79		7.64		6.3
Tolerance Index metric score	**3.87**	**71%**	**5.09**	**93%**	**3.75**	**69%**	**5.45**
Adjusted CPUE raw value	19.98		41.88		8.31		27.41
Adjusted CPUE metric score	**2**	**73%**	**4.19**	**153%**	**0.83**	**30%**	**2.74**
Pct DELT raw value	0		1.8		0.68		0.07

Color Key: (site-sample index/metric score is expressed as % of reference 25th%tle index/metric score)
<75% (not comparable to reference)
75-99% (marginal)
≥100% (comparable to reference)

Table 2-22 BMIBI Metric Comparison Table

	DRC 1		DRC 1		DRC 4		
Date	10/6/1999		10/5/2005		10/3/2005		**47c Ref. 25th %tile**
BMIBI score	48	83%	42	72%	38	66%	58
MH Total Taxa raw value	24		12		13		33
MH Total Taxa metric score	**5.7**	**89%**	**2.85**	**44%**	**3.95**	**61%**	**6.43**
SH Total Taxa raw value	7.67		12		6.33		13.82
SH Total Taxa metric score	**4.62**	**72%**	**7.23**	**113%**	**4.96**	**77%**	**6.42**
MH EPT Taxa raw value	10		4		4		16.38
MH EPT Taxa metric score	**5.06**	**82%**	**2.02**	**33%**	**2.57**	**42%**	**6.15**
SH EPT Taxa raw value	4.33		5.67		4.33		9.4
SH EPT Taxa metric score	**3.85**	**59%**	**5.05**	**78%**	**5.07**	**78%**	**6.5**
MH Sens Taxa raw value	2		0		0		5.75
MH Sens Taxa metric score	**2.26**	**41%**	**0**	**0%**	**0**	**0%**	**5.48**
SH Ephem Pct raw value	44.14		1.56		0.89		22.08
SH Ephem Pct metric score	**5.64**	**200%**	**0.2**	**7%**	**0.11**	**4%**	**2.82**
SH EPT Pct raw value	45.48		69.24		61.99		52.03
SH EPT Pct metric score	**4.76**	**87%**	**7.25**	**133%**	**6.49**	**119%**	**5.45**
SH Chiron Pct raw value	8.86		17.08		36.79		23.19
SH Chiron Pct metric score	**9.21**	**119%**	**8.38**	**108%**	**6.39**	**82%**	**7.76**
SH Scraper Pct raw value	0.94		2.84		0		8.01
SH Scraper Pct metric score	**0.21**	**12%**	**0.64**	**36%**	**0**	**0%**	**1.79**
SH 3Dom Pct raw value	87.33		71.61		83.23		73.23
SH 3Dom Pct metric score	**2.61**	**52%**	**5.85**	**116%**	**4.76**	**95%**	**5.03**
SH Dom FFG Pct raw value	64.29		67.16		65.56		60.26
SH Dom FFG Pct metric score	**5.95**	**90%**	**5.47**	**83%**	**5.74**	**87%**	**6.62**
MHBI raw value	4.88		5.41		5.52		5.28
MHBI metric score	**7.85**	**123%**	**5.89**	**92%**	**5.48**	**86%**	**6.37**

Color Key: (site-sample index/metric score is expressed as % of reference 25th%tle index/metric score)

<75% (not comparable to reference)

75-99% (marginal)

≥100% (comparable to reference)

Table 2-23 Fish RBP metric breakdown

	DRC 1	DRC 1	DRC 2	DRC 3	DRC 4	DRC 5	DRC 6U	DRC 6D1
Sample Date	1999	2005	2005	2005	2005	2005	2005	2005
Fish RBP Tol Value	1.53	1.72	1.67	1.69	1.63	1.51	1.77	1.26
Native Species raw value			3	5		3	5	5
Native Species metric score			4.52	7.73		4.84	9.77	10
Sucker Species raw value			0	3.00		0	1	1
Sucker Species metric score			0.00	6.98		0	6.24	6.24
Sensitive Species raw value			1	3.00		1	3	5
Sensitive Species metric score			4.40	3.98		0	7.13	10
BINV Species raw value			3	3.00		1	3	3
BINV Species metric score				3.79		1.68	3.39	3.39
Average metric score	3.5	2	2.5	3.5	2.5	2	3.5	3.5

	DRC 6D2	DRC 8	DRC 10	DRC 11	DRC 12	DRC 13	DRC 14	DRC 15
Sample Date	2005	2005	2005	2005	2005	2005	2005	2005
Fish RBP Tol Value	1.2	1.37	1.29	2.53	1.95	1.47	1.46	1.41
Native Species raw value	3	3	3	3	5	5	5	3
Native Species metric score	7.13	6.7	6.14	6.16	10	9.33	9.05	5.59
Sucker Species raw value	0	1	0	0	1	0	1	1
Sucker Species metric score	0	3.43	0	0	9.52	0	4.63	3.17
Sensitive Species raw value	3	1	1	3	5	3	1	1
Sensitive Species metric score	3.47	0	0	5.99	10	4.95	2.64	0
BINV Species raw value	3	1	1	5	5	1	1	1
BINV Species metric score	3.3	1.86	2.13	5.7	5.17	2.36	2.51	1.73
Average metric score	2.5	1.5	1.5	4	4.5	2.5	2	1.5

Raw value scores can be compared to expected 47c reference values using the following Key

1 – 2.9 = not comparable to reference

3 – 3.9 = marginally comparable to ref

4 – 5 = comparable to reference sites

Table 2-24 Benthicmacroinvertebrate RBP metric breakdown

	DRC 1	DRC 1	DRC 2	DRC 3	DRC 4	DRC 5	DRC 6U	DRC 6D1	DRC 6D2
Sample Date	1999	2005			2005	2005	2005	2005	2005
Invertebrate RBP Tol Value	4.96	4.26	4.96	3.44	5.49	6.22	6.38	5.04	5.84
Total Taxa Richness raw score	19	11	10	22	10	20	20	17	25
Total Taxa Richness metric score			3	3		5	5	5	5
# EPT taxa raw value	6	3	3	5	1	3	5	4	5
# EPT taxa metric score			3	3		1	5	5	5
Average metric score	3.7	2.3	3.7	3.7	1.7	2.3	3.7	4.3	4.3

	DRC 8	DRC 10	DRC 11	DRC 12	DRC 13	DRC 14	DRC 15
Sample Date	2005	2005	2005	2005	2005	2005	2005
Invertebrate RBP Tol Value	5.38	5.25	3.47	6.83	3.8	3.15	5.69
Total Taxa Richness raw score	23	24	17	12	25	21	16
Total Taxa Richness metric score	5	5	5	3	5	5	3
# EPT taxa raw value	4	5	4	1	7	3	4
# EPT taxa metric score	3	3	5	1	5	3	3
Average metric score	3.7	3.7	5	1.7	5	4.3	3

Metric scores can be compared to expected 47c reference values using the following Key

1 – 2.9 = not comparable to reference

3 – 3.9 = marginally comparable to ref

4 – 5 = comparable to reference sites

Table 2-25 Water quality on full biological sampling dates

Sample 10/3/2005	DRC 1	DRC 4	Conc.
Ammonia Nitrogen as N	< 0.05	< 0.05	mg/L
Carbonaceous BOD (5 day)		< 2	mg/L
Chloride	22	32	mg/L
Dissolved Oxygen	9.7	9.5	mg/L
Field pH	8.1	7.9	pH Units
Field Temperature	17.5	18.4	Degrees C
Flow Rate	21	15	cfs
Nitrate + Nitrite Nitrogen as N	2	2.6	mg/L
Ortho Phosphate as P	< 0.02	0.02	mg/L
Specific Conductance	570	630	umhos/cm
Total Kjeldahl Nitrogen as N	< 0.1	< 0.1	mg/L
Total Phosphate as P	0.03	0.03	mg/L
Total Suspended Solids		3	mg/L
Total Volatile Suspended Solids	1	< 1	mg/L
Turbidity	< 1	< 1	NTU

Table 2-26 Full biological sampling site fish species list

sample site	DRC 1	DRC 1	DRC 4
sample date	**10/6/1999**	**10/3/2005**	**10/3/2005**
sampling method	**Full**	**Full**	**Full**
bluntnose minnow *Pimephales notatus*	98	3	1
sand shiner *Notropis ludibundus*	59	128	
common shiner *Luxilus cornutus*	15		
bigmouth shiner *Notropis dorsalis*	40		
creek chub *Semotilus atromaculatus*	1		4
central stone roller *Campostoma anomalum*	5		1
hornyhead chub *Nocomis biguttatus*	1		
fathead minnow *Pimephales promelas*	8		
brassy minnow *Hybognathus hankinsoni*	8	1	
Spotfin shiner *Cyprinella spilopterus*	33	22	3
Golden shiner *Notemigonus crysoleucas*	2		
johnny darter *Etheostoma nigrum*	17	61	10
Mud darter *Etheostoma asprigene*	1		
Northern logperch *Percina caprodes*	1		2
Fantail darter *Etheostoma flabellare*	1		
white sucker *Catostomus commersoni*	3	11	38
Northern hog sucker *Hypentelium nigricans*	3	7	1
Shorthead redhorse *Moxostoma macrolepidotum*	1		
Brook silverside *Labidesthes sicculus*	1		

Table 2-24B Full biological sampling site fish species list

sample site	DRC 1	DRC 1	DRC 4
sample date	**10/6/1999**	**10/3/2005**	**10/3/2005**
sampling method	**Full**	**Full**	**Full**
green sunfish *Lepomis cyanellus*	33	173	75
Bluegill *Lepomis macrochirus*	12	15	11
Green sunf. X bluegill hybrid *Lepomis sp.*	3		
Orangespotted sunfish *Lepomis humilus*	1	2	
Largemouth bass *Micropterus salmoides*	1	11	
Smallmouth bass *Micropterus dolomieu*	10		
Northern pike *Esox lucius*	1		

Table 2-27 RBP site fish species list

sample site	DRC 2	DRC 3	DRC 5	DRC 6D1	DRC 6D2	DRC 6U	DRC 8
sample date	**10/3/2005**	**10/5/2005**	**10/4/2005**	**10/4/2005**	**10/4/2005**	**10/5/2005**	**10/4/2005**
sampling method	**RBP**	**RBP**	**RBP**	**RBP**	**RBP**	**RBP**	**RBP**
Bluntnose minnow *Pimephales notatus*		R	R	C			U
Sand shiner *Notropis ludibundus*		A					
Common shiner *Luxilus cornutus*		R			R		U
Bigmouth shiner *Notropis dorsalis*		U	U	C			C
Creek chub *Semotilus atromaculatus*		U	C	A	C	U	A
Southern redbelly dace *Phoxinus erythrogaster*				R		R	
Central stone roller *Campostoma anomalum*		U	C	C	R	R	U
Blacknose dace *Phoxinus cumberlandensis*	R	R	U	C		U	C
Hornyhead chub *Nocomis biguttatus*		R		R			
Fathead minnow *Pimephales promelas*			R	A		R	
Brassy minnow *Hybognathus hankinsoni*		R					
Spotfin shiner *Cyprinella spilopterus*		U					R
Johnny darter *Etheostoma nigrum*	R	C	U	U	R	R	C
Fantail darter *Etheostoma flabellare*							

R = rare (1-5), U = uncommon (6-20), C = common (21-100), and A = abundant (>100)

Table 2-25B RBP site fish species list

sample site	DRC 10	DRC 11	DRC 12	DRC 13	DRC 14	DRC 15
sample date	**10/4/2005**	**10/4/2005**	**10/4/2005**	**10/4/2005**	**10/4/2005**	**10/4/2005**
sampling method	**RBP**	**RBP**	**RBP**	**RBP**	**RBP**	**RBP**
Bluntnose minnow *Pimephales notatus*	C		R	C	U	R
Sand shiner *Notropis ludibundus*						
Common shiner *Luxilus cornutus*	U			R		
Bigmouth shiner *Notropis dorsalis*	C		R	U	U	R
Creek chub *Semotilus atromaculatus*	A	R	C	C	A	C
Southern redbelly dace *Phoxinus erythrogaster*			C	U	C	
Central stone roller *Campostoma anomalum*	C			C	U	R
Blacknose dace *Phoxinus cumberlandensis*	C		U	U	C	U
Hornyhead chub *Nocomis biguttatus*						
Fathead minnow *Pimephales promelas*			C	U	C	
Brassy minnow *Hybognathus hankinsoni*						
Spotfin shiner *Cyprinella spilopterus*						U
Johnny darter *Etheostoma nigrum*	U	R	U	U		U
Fantail darter *Etheostoma flabellare*					U	
R = rare (1-5), U = uncommon (6-20), C = common (21-100), and A = abundant (>100)						

Table 2-25C RBP site fish species list

sample site	DRC 2	DRC 3	DRC 5	DRC 6D1	DRC 6D2	DRC 6U	DRC 8
sample date	**10/3/2005**	**10/5/2005**	**10/4/2005**	**10/4/2005**	**10/4/2005**	**10/5/2005**	**10/4/2005**
sampling method	**RBP**	**RBP**	**RBP**	**RBP**	**RBP**	**RBP**	**RBP**
Brook stickleback *Culaea inconstans*				R	R	R	
White sucker *Catostomus commersoni*		C		U		R	R
Northern hog sucker *Hypentelium nigricans*		R					
Golden redhorse *Moxostoma erythrurum*		R					
Green sunfish *Lepomis cyanellus*	R	A	R		U		U
Bluegill *Lepomis macrochirus*		C					
Orangespotted sunfish *Lepomis humilus*		R					
Largemouth bass *Micropterus salmoides*		U			R		R
Smallmouth bass *Micropterus dolomieu*							
Northern rock bass *Ambioplites rupestris*		R					

R = rare (1-5), U = uncommon (6-20), C = common (21-100), and A = abundant (>100)

Table 2-25D RBP site fish species list

sample site	DRC 10	DRC 11	DRC 12	DRC 13	DRC 14	DRC 15
sample date	**10/4/2005**	**10/4/2005**	**10/4/2005**	**10/4/2005**	**10/4/2005**	**10/4/2005**
sampling method	**RBP**	**RBP**	**RBP**	**RBP**	**RBP**	**RBP**
Brook stickleback *Culaea inconstans*		U	C			
White sucker *Catostomus commersoni*			C		U	R
Northern hog sucker *Hypentelium nigricans*						
Golden redhorse *Moxostoma erythrurum*						
Green sunfish *Lepomis cyanellus*	C		U	R	C	R
Bluegill *Lepomis macrochirus*						
Orangespotted sunfish *Lepomis humilus*						
Largemouth bass *Micropterus salmoides*					R	R
Smallmouth bass *Micropterus dolomieu*				R		
Northern rock bass *Ambioplites rupestris*						

R = rare (1-5), U = uncommon (6-20), C = common (21-100), and A = abundant (>100)

Table 2-25 Full bio site invertebrate list

Phylum: Class	Order	Family	FinalID	DRC 1	DRC 1	DRC 4
				10/6/1999	10/3/2005	10/3/2005
Arthropoda: Insecta	Coleoptera	Elmidae	Dubiraphia		1	
			Optioservus		6	
			Stenelmis		2	
			Stenelmis grossa			1
	Diptera	Chironomidae	Chironomidae	40	49	117
		Culicidae	Anopheles	1		
		Empididae	Hemerodromia		5	
		Simuliidae	Simulium	148		
		Tabanidae	Chrysops		1	
		Tipulidae	Tipula	1	5	3
	Ephemeroptera	Caenidae	Caenis			1
			Caenis latipennis	5	1	
		Baetidae	Acentrella parvula	1		
			Baetis brunneicolor	23		
			Baetis flavistriga	141	3	
			Baetis tricaudatus	12		
		Heptageniidae	Stenacron interpunctatum	2		
			Heptagenia diabasia	8		
		Leptophlebiidae	Leptophlebia	3		
Arthropoda: Insecta cont.	Hemiptera	Hemiptera	Hemiptera	1		
		Corixidae	Sigara	1		
		Gerridae	Gerris		1	
			Gerridae		1	
	Megaloptera	Sialidae	Sialis	1		
	Odonata	Aeshnidae	Boyeria vinosa	1	1	4
		Calopterygidae	Calopteryx	3	12	9
		Coenagrionidae	Coenagrion/Enallagma		1	5
	Trichoptera	Brachycentridae	Brachycentrus numerosus		1	
		Hydropsychidae	Hydropsychidae		8	
			Ceratopsyche		1	7
			Ceratopsyche bronta	3	82	103
			Ceratopsyche morosa		13	31
			Ceratopsyche slossonae		1	
			Cheumatopsyche	2	74	54
			Hydropsyche betteni	4	18	32
		Hydroptilidae	Hydroptila		3	
		Leptoceridae	Leptoceridae	1		
		Philopotamidae	Chimarra		1	

Table 2-25B Full bio site invertebrate list

Phylum: Class	Order	Family	FinalID	DRC 1	DRC 1	DRC 4
				10/6/1999	10/3/2005	10/3/2005
Arthropoda: Arachnida			Hydracarina	2	4	
	Trombidiformes	Hydrachnidae	Hydrachnida		2	
Arthropoda: Crustacea			Hyalella		1	4
		Talitridae	Haylella azteca	7		
			Gammarus		2	
	Amphipoda	Gammaridae	Gammarus pseudolimnaeus	2		
			Cambaridae		2	
	Decapoda	Cambaridae	Orconectes			1
	Isopoda	Asellidae	Caecidotea	2		1
Annelida: Oligochaeta			Oligochaeta	8	10	
	Haplotaxida	Tubificidae	Tubificidae	2		
Annelida: Hirudinea	Arhynchobdellida	Erpobdellidae	Erpobdellidae	1		
Mollusca: Gastropoda	Basommatophora	Physidae	Physidae	4		
Nemata			Nemata		3	2

Table 2-28 RBP site invertebrate list

Phylum: Class	Order	Family	DRC 2	DRC 3	DRC 5	DRC 6D1	DRC 6D2	DRC 6U
			10/3/2005	10/5/2005	10/4/2005	10/4/2005	10/4/2005	10/5/2005
Arthropoda: Insecta	Coleoptera	Dryopidae			R			
		Dytiscidae		R		R	R	
		Elmidae		U		U	A	U
		Gyrinidae			R			
		Haliplidae			R		R	
		Hydrophilidae		R	R			R
	Diptera	Chironomidae	U	C	C	R	R	U
		Culicidae				R	R	
		Dixidae		R	R			
		Simuliidae		C				
		Syrphidae						R
		Tabanidae					R	
		Tipulidae	C	C	R	R		R
	Ephemeroptera	Caenidae		C	C	R	U	R
		Baetidae	A	U	C	R	U	R
		Baetiscidae						
		Ephemeridae						
		Heptageniidae		C		A	R	R
		Leptophlebiidae		C			R	R
	Hemiptera	Belostomatidae		R			R	
		Corixidae			R			
		Gerridae	U	C	U		U	C
		Nepidae			R			
		Veliidae		U				
	Odonata	Aeshnidae		U	R		R	R
		Calopterygidae	U	A	C	U	A	A
		Coenagrionidae		A	R	R	A	C
		Libellulidae						
	Trichoptera	Brachycentridae	R					
		Hydropsychidae	C	A	C	C	C	C
		Leptoceridae						
		Limnephilidae						

R = rare (1-5), U = uncommon (6-20), C = common (21-100), and A = abundant (>100)

Table 2-26B RBP site invertebrate list

Phylum: Class	Order	Family	DRC 8	DRC 10	DRC 11	DRC 12	DRC 13	DRC 14	DRC 15
			10/4/2005	10/4/2005	10/4/2005	10/4/2005	10/4/2005	10/4/2005	10/4/2005
Arthropoda: Insecta		Dryopidae			R			R	
		Dytiscidae			U	R		R	
		Elmidae	A	A	R		R		C
		Gyrinidae							
		Haliplidae				R	R		
	Coleoptera	Hydrophilidae	R	R				R	
		Chironomidae	U	C	U	C	R	U	U
		Culicidae				R	R	R	
		Dixidae	R					R	R
		Simuliidae	A	U	U		U		C
		Syrphidae							
		Tabanidae	R	R					
	Diptera	Tipulidae	U	U			R	R	U
		Caenidae	A	C			A		C
		Baetidae	A	C	R		C	C	A
		Baetiscidae					U		
		Ephemeridae					U		
		Heptageniidae	A	A	R		U	U	
	Ephemeroptera	Leptophlebiidae			R		R		C
		Belostomatidae							
		Corixidae		R			A	C	
		Gerridae	U	C	U	A	U	U	R
		Nepidae					R		
	Hemiptera	Veliidae	U						U
		Aeshnidae	R	U	C	U		C	R
		Calopterygidae	A	A	C	U	A	A	A
		Coenagrionidae	R	U		U	A	U	
	Odonata	Libellulidae			R				
		Brachycentridae							
		Hydropsychidae	A	A	U		C	A	C
		Leptoceridae		R					
	Trichoptera	Limnephilidae				R			

R = rare (1-5), U = uncommon (6-20), C = common (21-100), and A = abundant (>100)

Table 2-26C RBP site invertebrate list

Phylum: Class	Order	Family	DRC 2	DRC 3	DRC 5	DRC 6D1	DRC 6D2	DRC 6U
			10/3/2005	10/5/2005	10/4/2005	10/4/2005	10/4/2005	10/5/2005
Arthropoda: Crustacea	Amphipoda	Gammaridae		A	R		R	
		Cambaridae					R	
	Isopoda	Asellidae	U	U	R		U	U
Annelida: Oligochaeta	Haplotaxida	Lumbricidae	R			R		R
Annelida: Hirudinea	Arhynchobdellida	Erpobdellidae					R	
	Rhynchobdellida	Glossiphoniidae					R	
Mollusca: Bivalvia	Veneroida	Corbiculidae						
		Unionidae					R	
		Sphaeriidae				U		A
Mollusca: Gastropoda	Basommatophora	Ancylidae				U	C	C
		Lymnaeidae				R		
		Physidae	R	U	A	U	C	A
		Planorbidae				R	R	U
Platyhelminthes: Turbellaria	Tricladida	Dugesiidae		C	A			
R = rare (1-5), U = uncommon (6-20), C = common (21-100), and A = abundant (>100)								

Table 2-26D RBP site invertebrate list

Phylum: Class	Order	Family	DRC 8	DRC 10	DRC 11	DRC 12	DRC 13	DRC 14	DRC 15
			10/4/2005	10/4/2005	10/4/2005	10/4/2005	10/4/2005	10/4/2005	10/4/2005
Arthropoda: Crustacea		Gammaridae	R	U	C		A	A	
	Amphipoda	Cambaridae	R	R	R		U		
	Isopoda	Asellidae	R	R	C	R	R		R
Annelida: Oligochaeta	Haplotaxida	Lumbricidae							
Annelida: Hirudinea	Arhynchobdellida	Erpobdellidae		R			R	R	
	Rhynchobdellida	Glossiphoniidae						R	
Mollusca: Bivalvia		Corbiculidae	U						
		Unionidae							
	Veneroida	Sphaeriidae		A		R	A		
Mollusca: Gastropoda		Ancylidae	A				C		
		Lymnaeidae							
		Physidae	R	U	C	A	C	A	A
	Basommatophora	Planorbidae		R				R	
Platyhelminthes: Turbellaria	Tricladida	Dugesiidae	C	A				R	U

R = rare (1-5), U = uncommon (6-20), C = common (21-100), and A = abundant (>100)

Table 2-29 UNI Ecotoxicological study: Outfall toxicity testing

UNI Outfall Toxicity Testing			
Site	**Map #**	**Date**	**Spearman_Karber LC50**
Univ. Bridge E.	7	5/24/2006	13.75%
UNI Towers	6	5/24/2006	20.31%
Univ. Bridge W.	8	5/24/2006	43.13%
UNI Towers	6	6/17/2006	61.88%
UNI Towers	6	8/19/2006	43.38%
Univ. Bridge E.	7	9/19/2006	33.75%
UNI Towers	6	9/19/2006	10.78%
UNI Towers	6	10/24/2006	5.94%
Panther Lane	11	12/29/2006	24.38%
Tall Grass Prairie	15	4/28/2007	3.75%

Habitat Data

Table 2-30 Habitat Parameters from Full Biological Site DRC 1 2005

HabParamID	HabLocID	HabValue	Above/Below Eco Region
Canopy - Average Percent of Channel Shaded		80.45	Above
Canopy - Standard Deviation - Percent of Channel Shaded		16.02	Below
Canopy - Transect Maximum Percent of Channel Shaded		95.5	-
Canopy - Transect Minimum Percent of Channel Shaded		63.96	Above
Coarse Rock Embededness - Average		4	Above
Fish Cover - Large Features Areal Cover - EPA Method		7.5	-
Fish Cover - Large Features Areal Cover - IDNR Method		7.5	Below
Fish Cover - Natural Concealment Features		5.5	Below
Fish Cover - Total Proportional Areal Cover - IDNR Method		12	Below
Fish Cover - Total Proportional Areal Cover - EPA Method		11	Below
Instream Cover - Artificial Structure - Average Percent		6	Above
Instream Cover - Boulders - Average Percent		0	-
Instream Cover - Depth/Pool - Average Percent - IDNR Method		0.5	Below
Instream Cover - Filamentous Algae - Average Percent		0.5	-
Instream Cover - Macrophytes - Average Percent		0	-
Instream Cover - Overhanging Vegetation - Average Percent		0.5	Below
Instream Cover - Small Brush - Average Percent		3	Below
Instream Cover - Trees/Roots - Average Percent		0.5	Below
Instream Cover - Undercut Banks - Average Percent		0	Below
Instream Cover - Woody Debris - Average Percent		1	-
Macrohabitat - Percent Pool		3.6	Below
Macrohabitat - Percent Riffle		1.8	-
Macrohabitat - Percent Run		94.6	Above
Maximum Depth		3.45	-
Reach - Percent Soft Sediment		67.9	-
Reach - Total Habitat Reach Length		666	Below
Stream Width - Average		34.2	-
Streambank - Percent Bare	Left Bank	57.5	-
Streambank - Percent Bare	Right Bank	64.5	-
Streambank Angle - Percent Horizontal (0-15 degrees)	Left Bank	30	-
Streambank Angle - Percent Horizontal (0-15 degrees)	Right Bank	20	Below
Streambank Angle - Percent Moderate (20-50 degrees)	Left Bank	60	Above
Streambank Angle - Percent Moderate (20-50 degrees)	Right Bank	70	Above
Streambank Angle - Percent Undercut (115-180 degrees)	Left Bank	0	-
Streambank Angle - Percent Undercut (115-180 degrees)	Right Bank	0	-
Streambank Angle - Percent Vertical (55-110 degrees)	Left Bank	10	Below
Streambank Angle - Percent Vertical (55-110 degrees)	Right Bank	10	Below
Substrate - Percent Bedrock		0	-
Substrate - Percent Boulder		0	-
Substrate - Percent Clay		0	-
Substrate - Percent Cobble		8	-
Substrate - Percent Detritus/Muck		0	-
Substrate - Percent Gravel		29	Above
Substrate - Percent Other		0	-
Substrate - Percent Rip-Rap		8	Above
Substrate - Percent Sand		44	-
Substrate - Percent Silt		11	-
Substrate - Percent Soil		0	-
Substrate - Percent Wood		0	-
Thalweg Depth - Average		1.8375	-
Transect Depth - Average		0.87	-
Transect Depth - Standard Deviation		0.51	-
Width - Thalweg Depth Ratio		18.6	Below

Table 2-28 Habitat Parameters from Full Biological Site DRC 1 1999

HabParamID	HabLocID	HabValue	Above/Below Ecoregion
Canopy - Average Percent of Channel Shaded		74.32	-
Canopy Standard Deviation - Percent of Channel Shaded		30.32	-
Canopy - Transect Maximum Percent of Channel Shaded		100	Above
Canopy - Transect Minimum Percent of Channel Shaded		3.6	-
Coarse Rock Embededness - Average		1.5	Below
Instream Cover - (Legacy) - Reach Average Percent		22	Above
Macrohabitat - Percent Pool		35.7	-
Macrohabitat - Percent Riffle		0	-
Macrohabitat - Percent Run		64.3	-
Maximum Depth		5	Above
Maximum Depth Exceeds Measuring Capacity		-1	-
Reach - (Legacy) Large Woody Debris - Average		35.7	-
Reach - Total Habitat Reach Length		702	-
Stream Width - Average		34.37	-
Streambank - Percent Bare	Left Bank	75	-
Streambank - Percent Bare	Right Bank	46	Below
Streambank Angle - Percent Horizontal (0-15 degrees)	Left Bank	30	-
Streambank Angle - Percent Horizontal (0-15 degrees)	Right Bank	20	Below
Streambank Angle - Percent Moderate (20-50 degrees)	Left Bank	40	-
Streambank Angle - Percent Moderate (20-50 degrees)	Right Bank	70	Above
Streambank Angle Percent Undercut (115-180 degrees)	Left Bank	0	-
Streambank Angle Percent Undercut (115-180 degrees)	Right Bank	0	-
Streambank Angle - Percent Vertical (55-110 degrees)	Left Bank	30	Above
Streambank Angle - Percent Vertical (55-110 degrees)	Right Bank	10	-
Substrate - Percent Bedrock		0	-
Substrate - Percent Boulder		6	Above
Substrate - Percent Clay		0	-
Substrate - Percent Cobble		0	-
Substrate - Percent Detritus/Muck		0	-
Substrate - Percent Gravel		40	Above
Substrate - Percent Other		0	-
Substrate - Percent Rip-Rap		10	Above
Substrate - Percent Sand		40	-
Substrate - Percent Silt		4	Below
Substrate - Percent Soil		0	-
Substrate - Percent Wood		0	-
Thalweg Depth - Average		2.56	Above
Transect Depth - Average		1.58	Above
Transect Depth - Standard Deviation		1.21	Above
Width - Thalweg Depth Ratio		13.4	Below

Table 2-31 Habitat Parameters from Full Biological Site DRC 4 2005

HabParamID	HabLocID	Hab Value	Above/Below Ecoregion
Canopy - Average Percent of Channel Shaded		98.29	Above
Canopy - Standard Deviation - Percent of Channel Shaded		3.58	Below
Canopy - Transect Maximum Percent of Channel Shaded		100	Above
Canopy - Transect Minimum Percent of Channel Shaded		92.79	Above
Coarse Rock Embededness - Average		3.5	Above
Fish Cover - Large Features Areal Cover - EPA Method		19	Above
Fish Cover - Large Features Areal Cover - IDNR Method		22	Above
Fish Cover - Natural Concealment Features		20.5	-
Fish Cover - Total Proportional Areal Cover - IDNR Method		28	-
Fish Cover - Total Proportional Areal Cover - EPA Method		23	-
Instream Cover - Artificial Structure - Average Percent		2.5	Above
Instream Cover - Boulders - Average Percent		3	-
Instream Cover - Depth/Pool -Average Percent -IDNR Method		5	-
Instream Cover - Filamentous Algae - Average Percent		0	-
Instream Cover - Macrophytes - Average Percent		0	-
Instream Cover - Overhanging Vegetation - Average Percent		1.5	-
Instream Cover - Small Brush - Average Percent		2.5	Below
Instream Cover - Trees/Roots - Average Percent		7	Above
Instream Cover - Undercut Banks - Average Percent		5	Above
Instream Cover - Woody Debris - Average Percent		1.5	-
Macrohabitat - Percent Pool		26.8	-
Macrohabitat - Percent Riffle		14.3	Above
Macrohabitat - Percent Run		58.9	-
Maximum Depth		3.5	-
Reach - Percent Soft Sediment		60.7	-
Reach - Total Habitat Reach Length		756	Below
Stream Width - Average		20.29	Below
Streambank - Percent Bare	Left Bank	78.5	Above
Streambank - Percent Bare	Right Bank	83.5	Above
Streambank Angle - Percent Horizontal (0-15 degrees)	Left Bank	0	Below
Streambank Angle - Percent Horizontal (0-15 degrees)	Right Bank	0	Below
Streambank Angle - Percent Moderate (20-50 degrees)	Left Bank	80	Above
Streambank Angle - Percent Moderate (20-50 degrees)	Right Bank	40	-
Streambank Angle - Percent Undercut (115-180 degrees)	Left Bank	10	Above
Streambank Angle - Percent Undercut (115-180 degrees)	Right Bank	10	Above
Streambank Angle - Percent Vertical (55-110 degrees)	Left Bank	10	Below
Streambank Angle - Percent Vertical (55-110 degrees)	Right Bank	50	Above
Substrate - Percent Bedrock		0	-
Substrate - Percent Boulder		5	Above
Substrate - Percent Clay		2	Above
Substrate - Percent Cobble		27	Above
Substrate - Percent Detritus/Muck		2	-
Substrate - Percent Gravel		9	-
Substrate - Percent Other		0	-
Substrate - Percent Rip-Rap		0	-
Substrate - Percent Sand		45	-
Substrate - Percent Silt		7	-
Substrate - Percent Soil		2	Above
Substrate - Percent Wood		2	Above
Thalweg Depth - Average		2.01	-
Transect Depth - Average		1.34	Above
Transect Depth - Standard Deviation		0.65	-
Width - Thalweg Depth Ratio		10.1	Below

Table 2-32 RBP Habitat Data

Habitat Parameter	Bank	DRC 2	DRC 5	DRC 6 D2	DRC 6U	DRC 8	DRC 10
Epifaunal Substrate/Available Cover		<20% available	40-70% avalible	<20% available	20- 40 % available	20- 40 % available	20- 40 % available
Embeddedness		50-75% embedded	50-75% embedded	>75% embedded	50-75% embedded	50-75% embedded	50-75% embedded
Velocity/Depth Regime		dominated by 1 flow regime	2 of 4	dominated by 1 flow regime	2 of 4	3 of 4	3 of 4
Sediment Deposition		Heavy sed >50% bottom affected	moderate sed 30-50% bottom	Heavy sed >50% bottom affected	moderate sed 30-50% bottom	moderate sed 30-50% bottom	5-30% channel affected
Channel Flow Status		25-75% channel filled w/water	> 75% filled	Mostly standing pools	25-75% channel filled w/water	25-75% channel filled w/water	water fills over 75% of channel
Channel Alteration		40-80% altered	> 80% altered	> 80% altered	40-80% altered	absent	absent
Frequency of Riffles (or bends)		occasional riffle or bend	infrequent	flat water	occasional riffle or bend	occasional riffle or bend	infrequent
Bank Stability	Left Bank	Moderately stable	Stable	Moderately stable	moderately stable	moderately unstable	moderately unstable
Bank Stability	Right Bank	Moderately stable	Stable	Moderately stable	moderately stable	moderately unstable	moderately unstable
Vegetation Protection	Left Bank	50-70% covered	50-70% covered	50-70% covered	50-70% covered	>90% covered	>90% covered
Vegetation Protection	Right Bank	70-90% covered	50-70% covered	50-70% covered	50-70% covered	>90% covered	>90% covered
Riparian Vegetative Zone Width	Left Bank	< 1meter	< 1meter	< 6 meters	6-12 meters	>18 meters	>18 meters
Riparian Vegetative Zone Width	Right Bank	>18 meters	< 1meter	< 6 meters	< 6 meters	>18 meters	>18 meters

Table 2-30–B RBP Habitat Data

Habitat Parameter	Bank	DRC 11	DRC 12	DRC 13	DRC 14	DRC 15
Epifaunal Substrate/Available Cover		<20% available	20- 40 % available	40-70% avalible	20- 40 % available	<20% available
Embeddedness		>75% embedded	50-75% embedded	25-50% embedded	50-75% embedded	>75% embedded
Velocity/Depth Regime		dominated by 1 flow regime	2 of 4	3 of 4	3 of 4	2 of 4
Sediment Deposition		Heavy sed >50% bottom affected	moderate sed 30-50% bottom	moderate sed 30-50% bottom	Heavy sed >50% bottom affected	Heavy sed >50% bottom affected
Channel Flow Status		Mostly standing pools	> 75% filled	>75% filled	25-75% channel filled w/water	25-75% channel filled w/water
Channel Alteration		> 80% altered	40-80% altered	some channelization (old)	some (old)	absent
Frequency of Riffles (or bends)		flat water	flat water	infrequent	occasional riffle or bend	flat water
Bank Stability	Left Bank	moderately stable	Moderately stable	moderately stable	moderately stable	moderately unstable
Bank Stability	Right Bank	moderately stable	Moderately stable	moderately stable	moderately stable	moderately unstable
Vegetation Protection	Left Bank	50-70% covered	50-70% covered	70-90% covered	>90% covered	>90% covered
Vegetation Protection	Right Bank	50-70% covered	50-70% covered	70-90% covered	>90% covered	>90% covered
Riparian Vegetative Zone Width	Left Bank	6-12 meters	6-12 meters	12-18 meters	12-18 Meters	> 18 meters
Riparian Vegetative Zone Width	Right Bank	6-12 meters	12-18 meters	>18 meters	12-18 Meters	> 18 meters

Table 2-33 RBP SI Habitat Observations

Site	Altered Flow- Lack of channel sinuosity	Altered Flow- Deep channel incision	Altered Flow- Low flow wetted stream margine not in contact with banks	Altered Flow- Monotypic flow pattern	Altered Flow- Flow impoundment (man made)	Altered Substrate- Excessive coarse rock substrate embeddedness in riffles/runs	Altered Substrate - Silt covering much of stream bottom/ coarse rock substrates	Altered Substrate - Excessive sediment bar development	Altered Substrate - Significan reduction in pool depth due to sedimentation
DRC 2	X	X		X		X			
DRC 3	X	X							
DRC 5	X	X							
DRC 6 D1	X	X	X			X	X		
DRC 6 D2	X	X	X	X			X		X
DRC 6 U	X	X	X		X	X	X	X	
DRC 8		X				X			
DRC 10		X							
DRC 11	X	X					X		
DRC 12	X	X		X			X		X
DRC 13						X	X		
DRC 14									
DRC 15			X					X	X

Site	Altered Substrate- Excessive substrate instability - shifting sand	Altered Substrate- Excessive substrate instability- scoured rock	Altered Substrate- Excessive filamentous algal growth on coarse substrates	Altered Substrate- No algal colonization on coarse substrates	Altered Substrate- Minimal leaf litter, detritus, small woody debris	Altered Substrate- Minimal large woody debris	Riparian- Excessive streambank erosion and/or sloughing	Riparian- Little to no shade over stream channel
DRC 2	X	X	X		X	X	X	
DRC 3		X				X		
DRC 5		X				X		X
DRC 6 D1								
DRC 6 D2			X			X		X
DRC 6 U				X				
DRC 8		X						
DRC 10		X						
DRC 11								
DRC 12	X	X						
DRC 13						X		X
DRC 14								
DRC 15	X						X	

Table 2-34 UNI Stream Channel Analysis

First Order Tributaries		
Parameter	**Length (ft)**	**Percentage of surveyed length (unless noted)**
Channel with urban land use in riparian corridor	14,690	16%
Channel with row crop land use in riparian corridor	61,978	68%
Channel with livestock access to stream	5,868	6%
▪ Silt as dominant substrate	4,622	% of livestock length 79%
Channel which is coarse substrate dominated	5,503	6%
Channel which is silt dominated	63,163	70%
Channel with no pool habitat	68,006	75%
▪ Silt as dominant substrate	59,068	% of no pool length 87%
Channel with more than 1 3' pool every 250' or frequent pools	2,511	3%
Channel with moderately unstable to unstable streambanks (avg. height 5.0 ft)	35,547	39%
Channel with 50% or more canopy coverage	21,577	24%
Channel with <10% canopy coverage	34,099	38%
Channel with habitat available in		
▪ <30% of section	42,551	47%
▪ >30% of section	857	<1%
▪ None available	34,441	38%

Table 2-32B UNI Stream Channel Analysis

Second Order Tributaries		
Parameter	**Length (ft)**	**Percentage of surveyed length (unless noted)**
Channel with urban land use in riparian corridor	5,893	13%
Channel with row crop land use in riparian corridor (all of this has < 30% habitat available)	20,890	47%
Channel with livestock access to stream	528	1%
Channel which is coarse substrate dominated	2,597	6%
Channel which is silt/sand dominated	31,100	69%
Channel with no pool habitat ▪ Silt as dominant substrate	11,888 6,710	27% % no pool length 56%
Channel with more than 1 3' pool every 250' or frequent pools	17,576	39%
Channel with moderately unstable to unstable streambanks (avg. height 5.6 ft)	29,754	66%
Channel with moderately stable to stable streambanks (avg. height 4.6ft)	14,339	32%
Channel with 50% or more canopy coverage	16,935	38%
Channel with <10% canopy coverage	7,669	17%
Channel with habitat available in ▪ <30% of section ▪ >30% of section ▪ None available	 38,685 1,531 3,378	 87% 3% 8%

Table 2-32C UNI Stream Channel Analysis

Third Order Tributaries/Main Stem		
Parameter	**Length (ft)**	**Percentage of surveyed length (unless noted)**
Channel with urban land use in riparian corridor	3,675	23%
Channel with row crop land use in riparian corridor (all of this has < 30% habitat available)	0	0
Channel with livestock access to stream	0	0
Channel which is coarse substrate dominated	4,936	30%
Channel which is silt/sand dominated	6,769	42%
Channel with no pool habitat	1,167	7%
Channel with more than 1 3' pool every 250' or frequent pools	5,908	36%
Channel with moderately unstable to unstable streambanks (avg. height 8.9 ft)	5,720	35%
Channel with moderately stable to stable streambanks (avg. height 7.2ft)	9,719	60%
Channel with 50% or more canopy coverage	6,570	40%
Channel with <10% canopy coverage	279	<10%
Channel with habitat available in ▪ <30% of section ▪ >30% of section ▪ None available	 14,765 0 1,559	 90% 0 10%

Table 2-35 Past and Present Day Channel Comparison

1930's & 2006 Channel Comparison			
Location	**1930's**	**2006**	**Change**
Main channel length	7,614 ft	7,030 ft	-584 ft (8%)
Main channel sinuosity	1.33	1.28	-.05
North West branch length	15,481 ft	13,425 ft	-2,056 ft (13%)
North West branch sinuosity	1.2	1.18	-.02
South East branch length	59,370 ft	49,927 ft	-9,443 ft (16%)
South East branch sinuosity	1.18	1.13	-.05
South West branch length	62,848	57,194	-5,654 (9%)
South West branch sinuosity	1.18	1.18	0
Total channel length	145,312	127,575	-17,737 (12.2%)
Total channel sinuosity	1.2	1.7	-.03

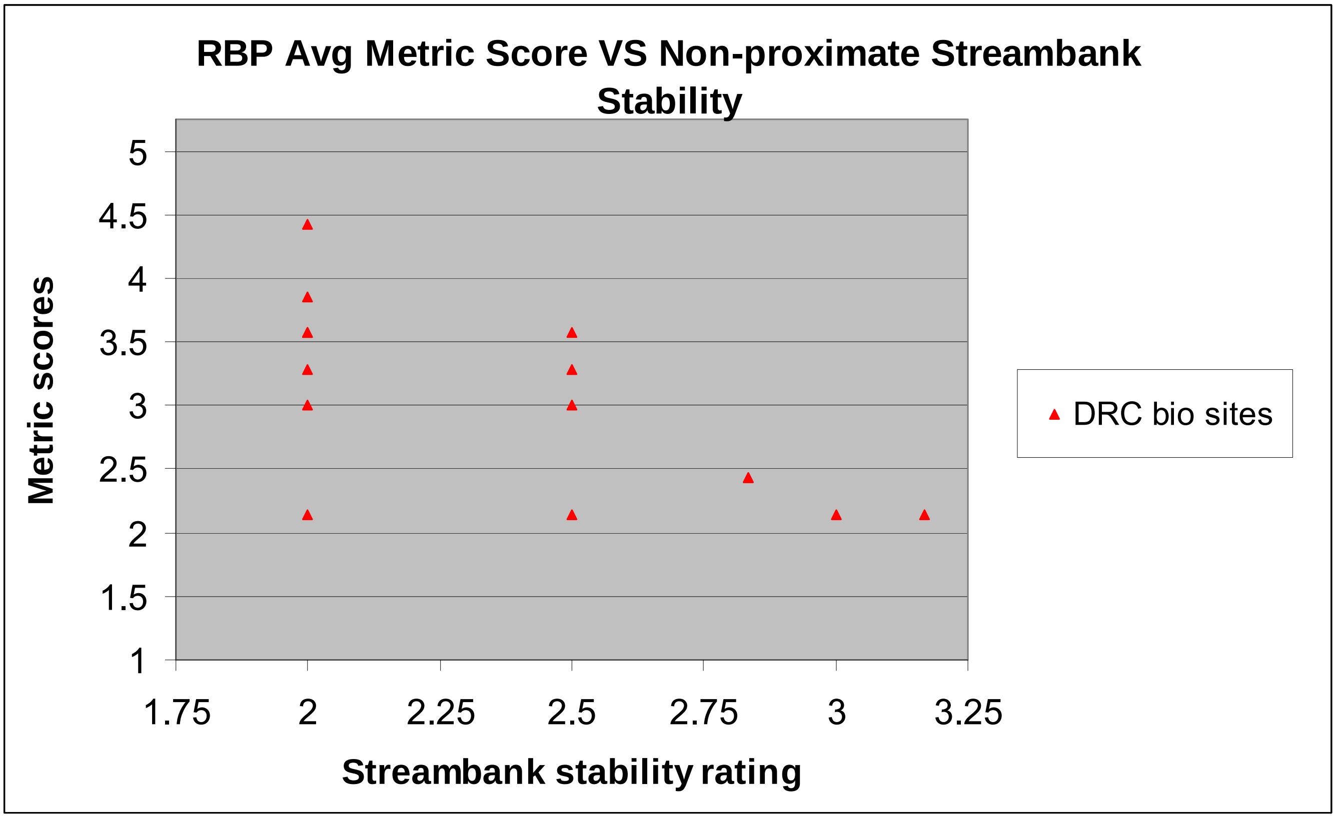


Figure 2-1 Dry Run Creek average RBP metric scores and associated site streambank stability rating from non-proximate stressor ranking exercise (Appendix)

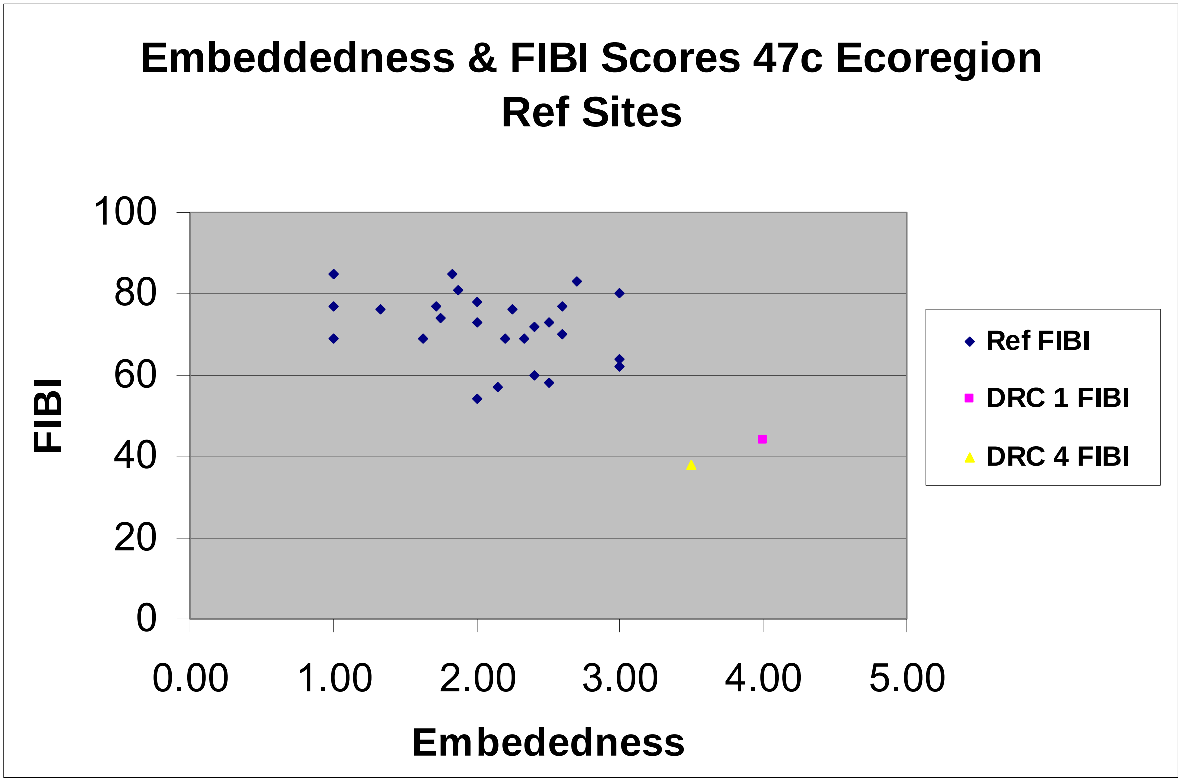


Figure 2-2 Embeddedness rankings and FIBI scores for ecoregion reference sites

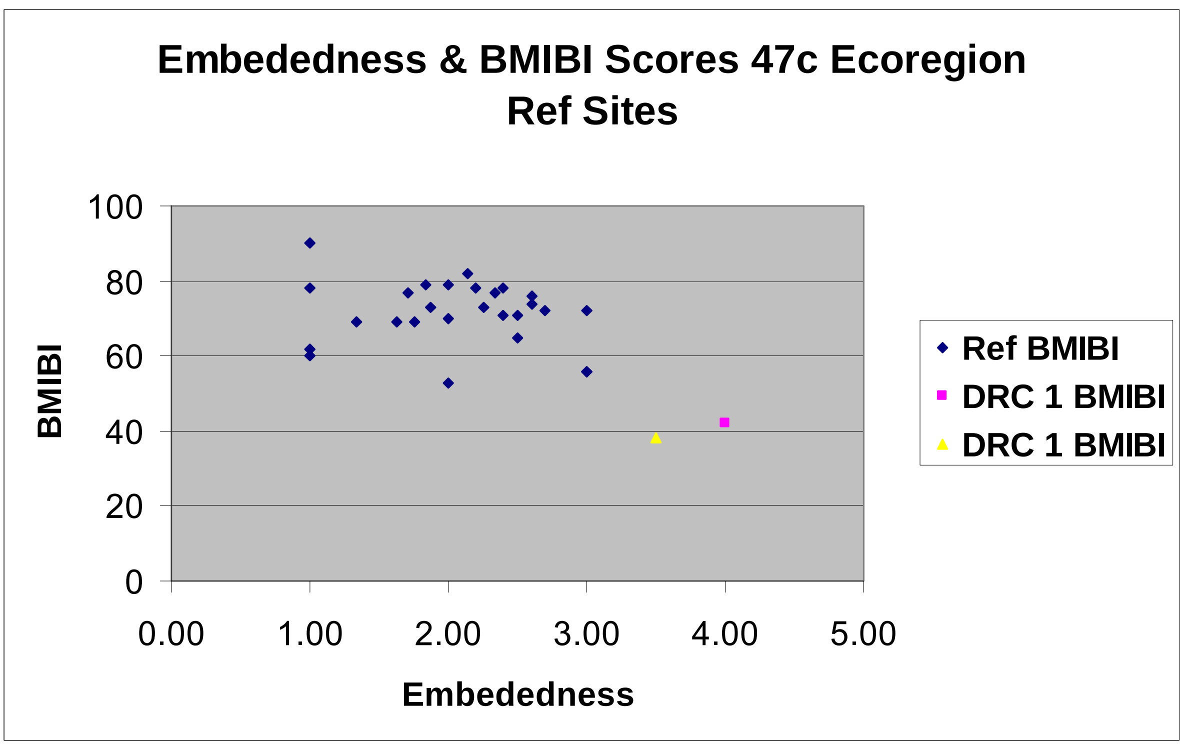
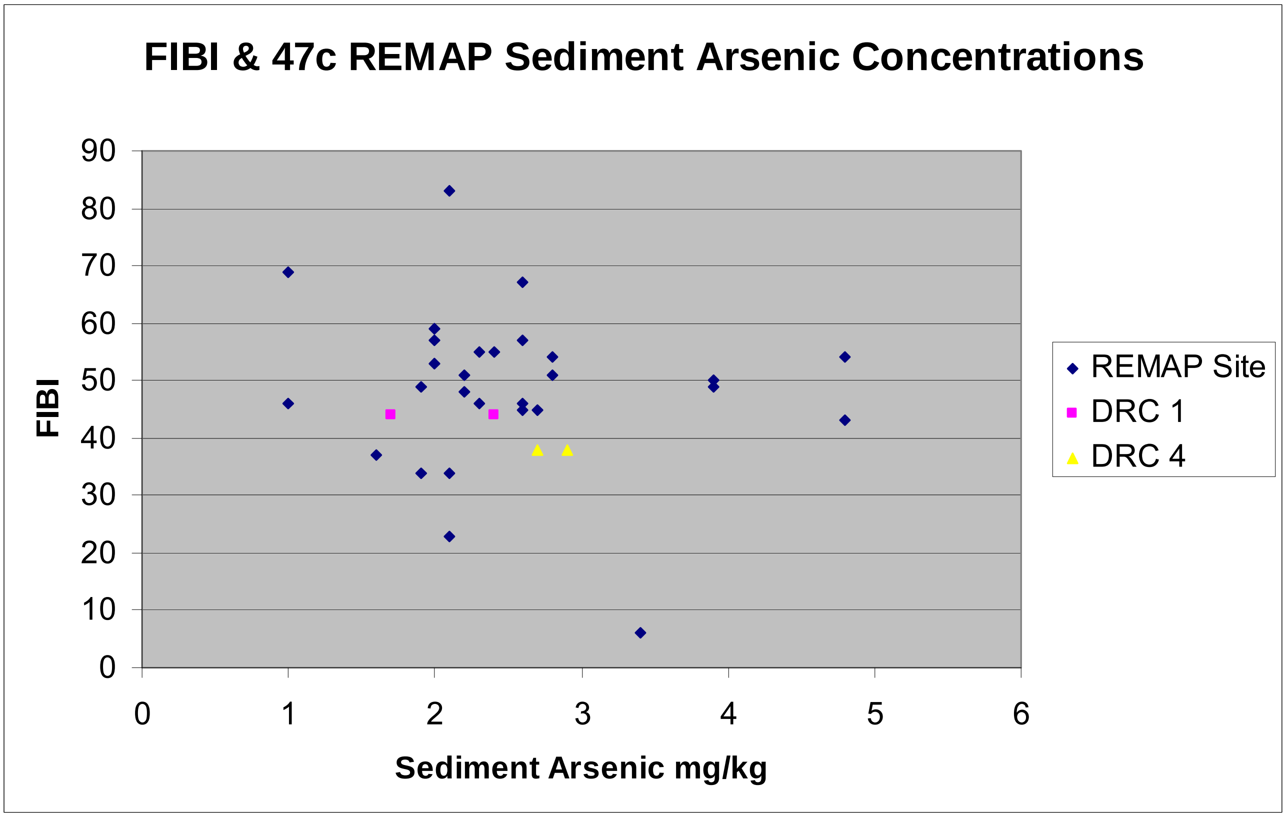


Figure 2-2B Embeddedness rankings and BMIBI scores for ecoregion reference sites



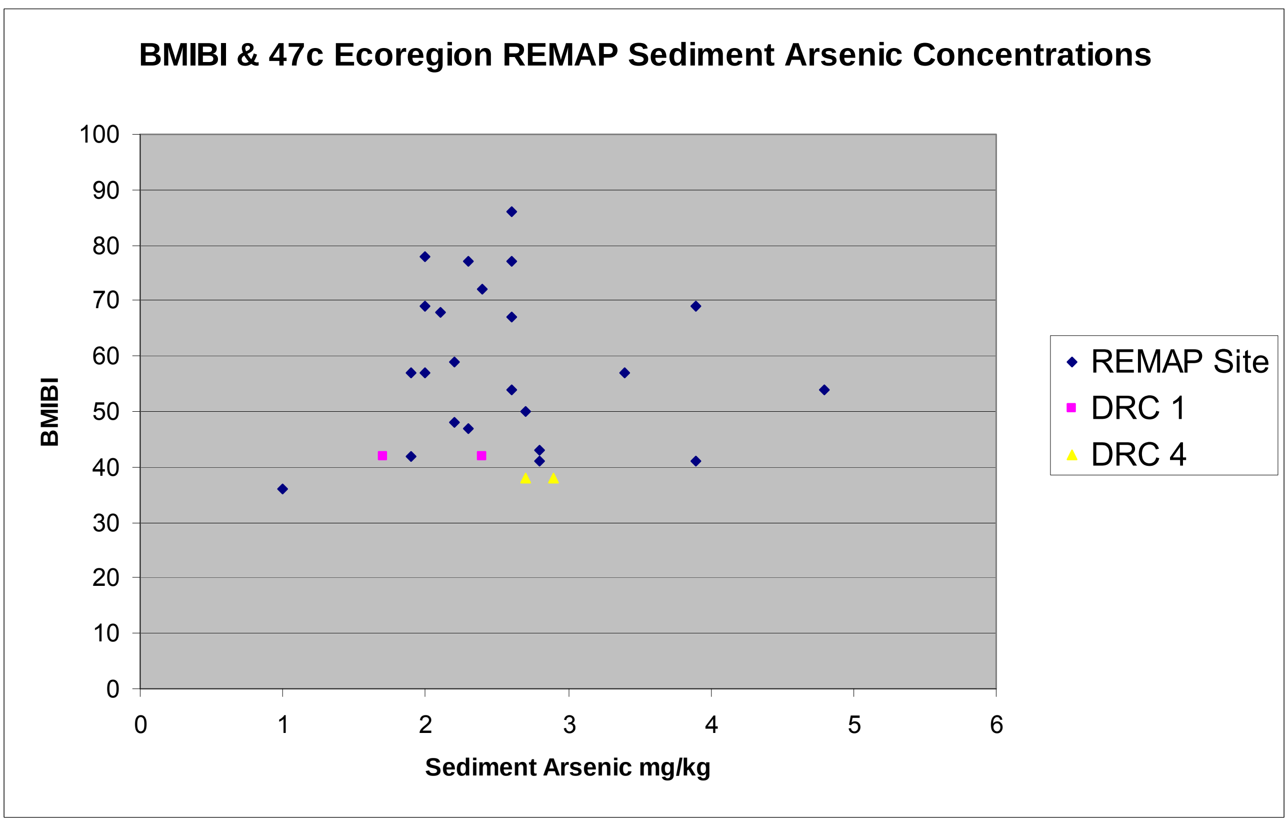
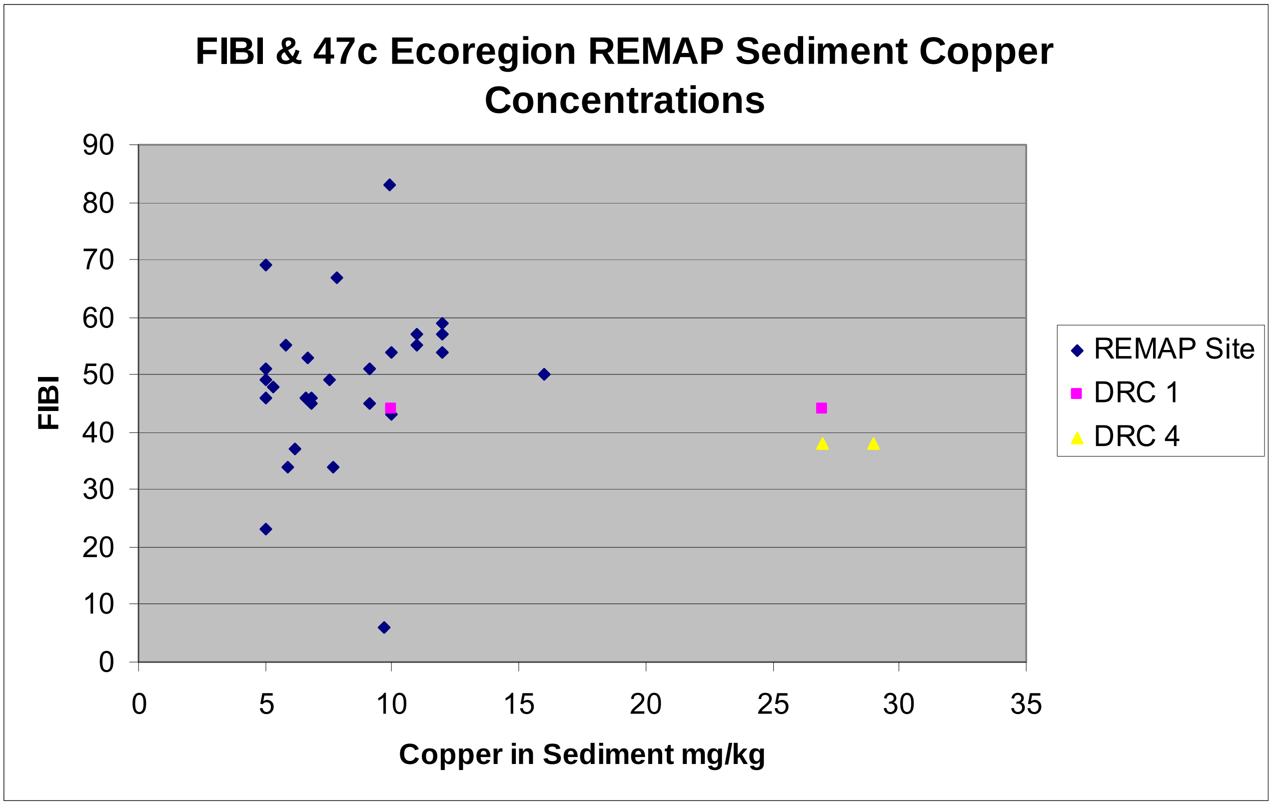


Figure 2-3 47c ecoregion REMAP sediment arsenic concentration with associated FIBI & BMIBI Scores



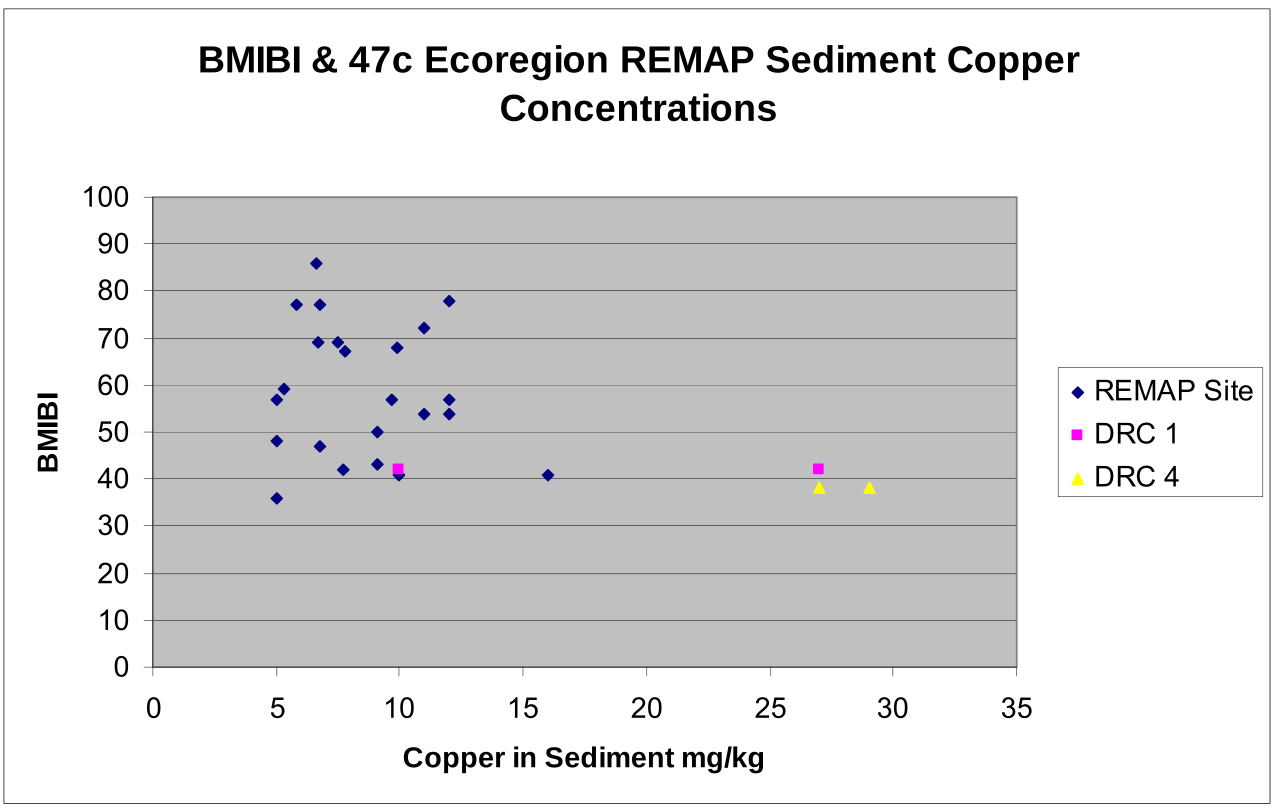
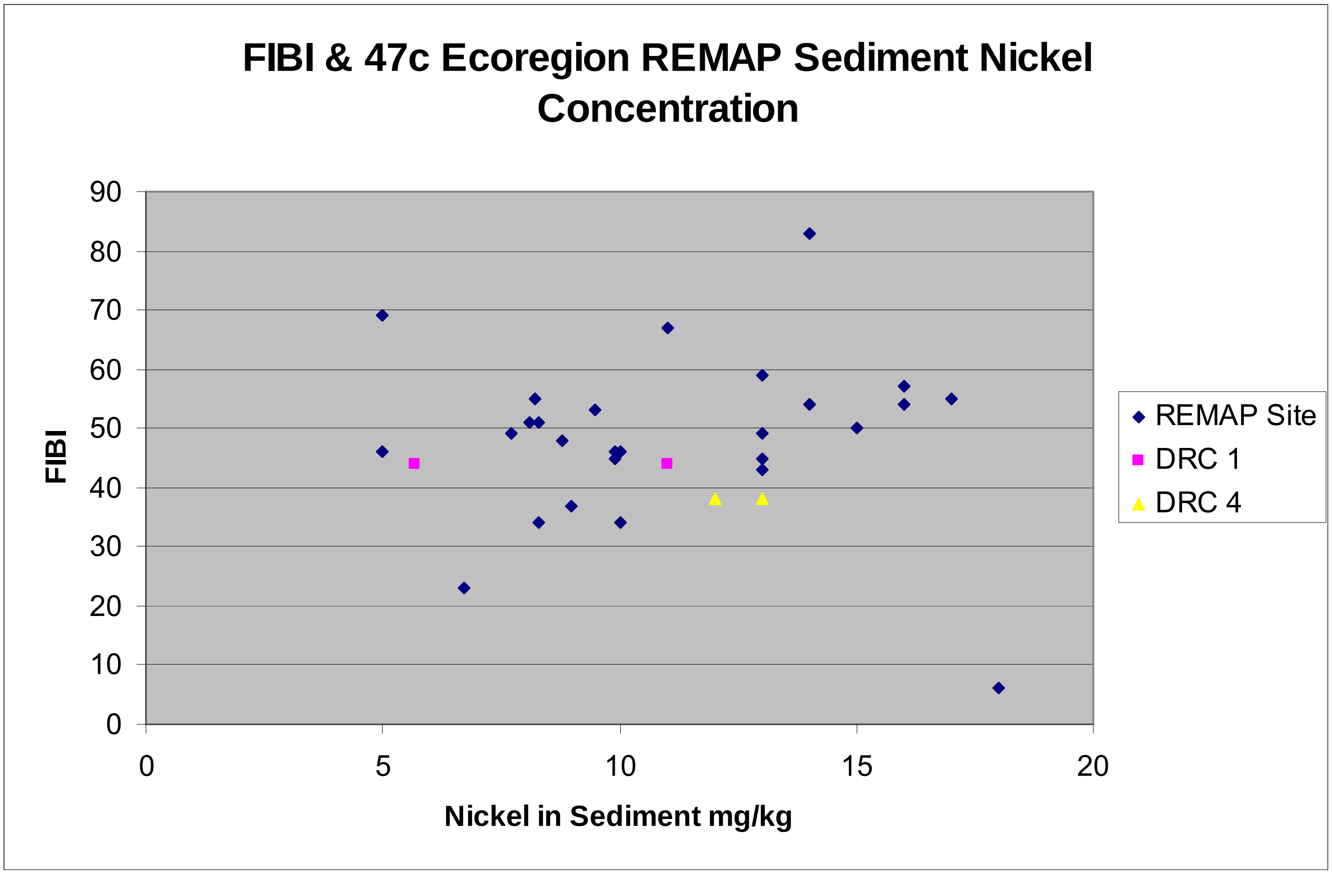


Figure 2-4 47c ecoregion REMAP sediment copper concentration with associated FIBI & BMIBI Scores



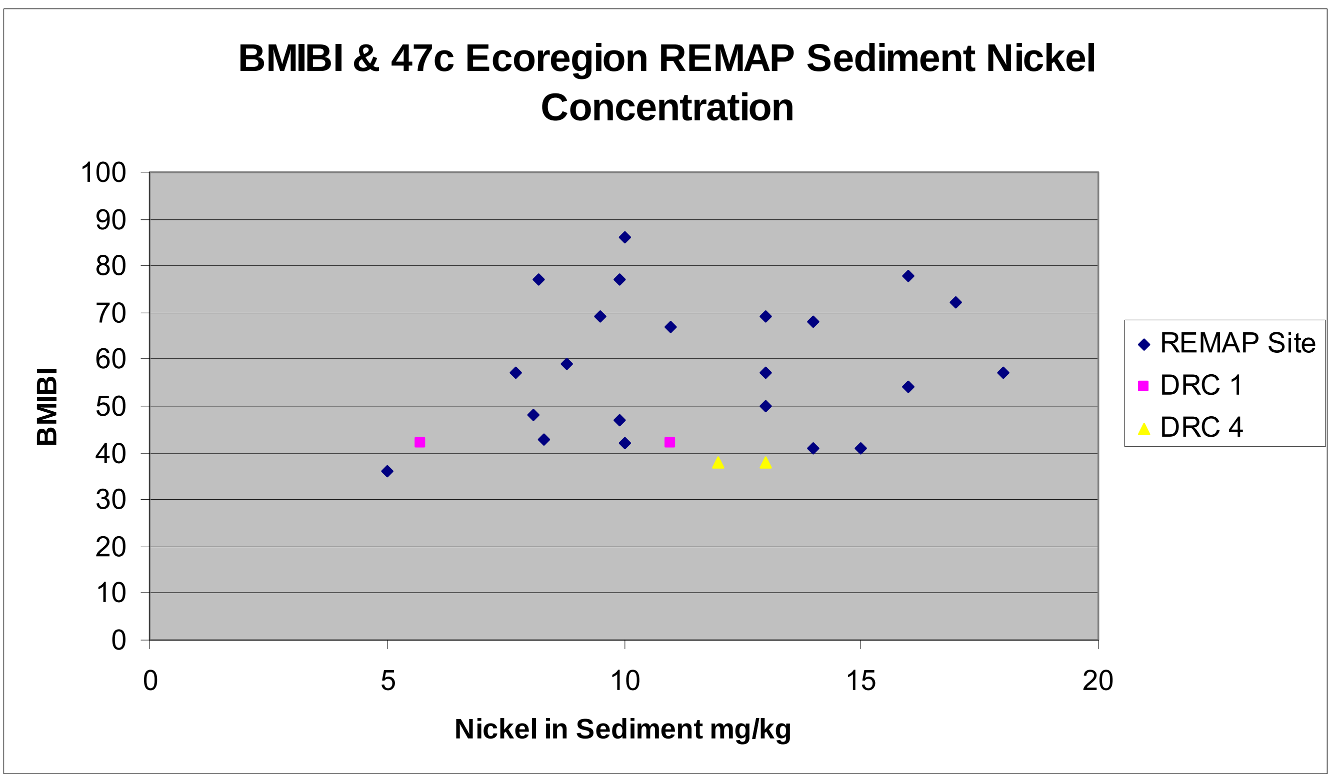
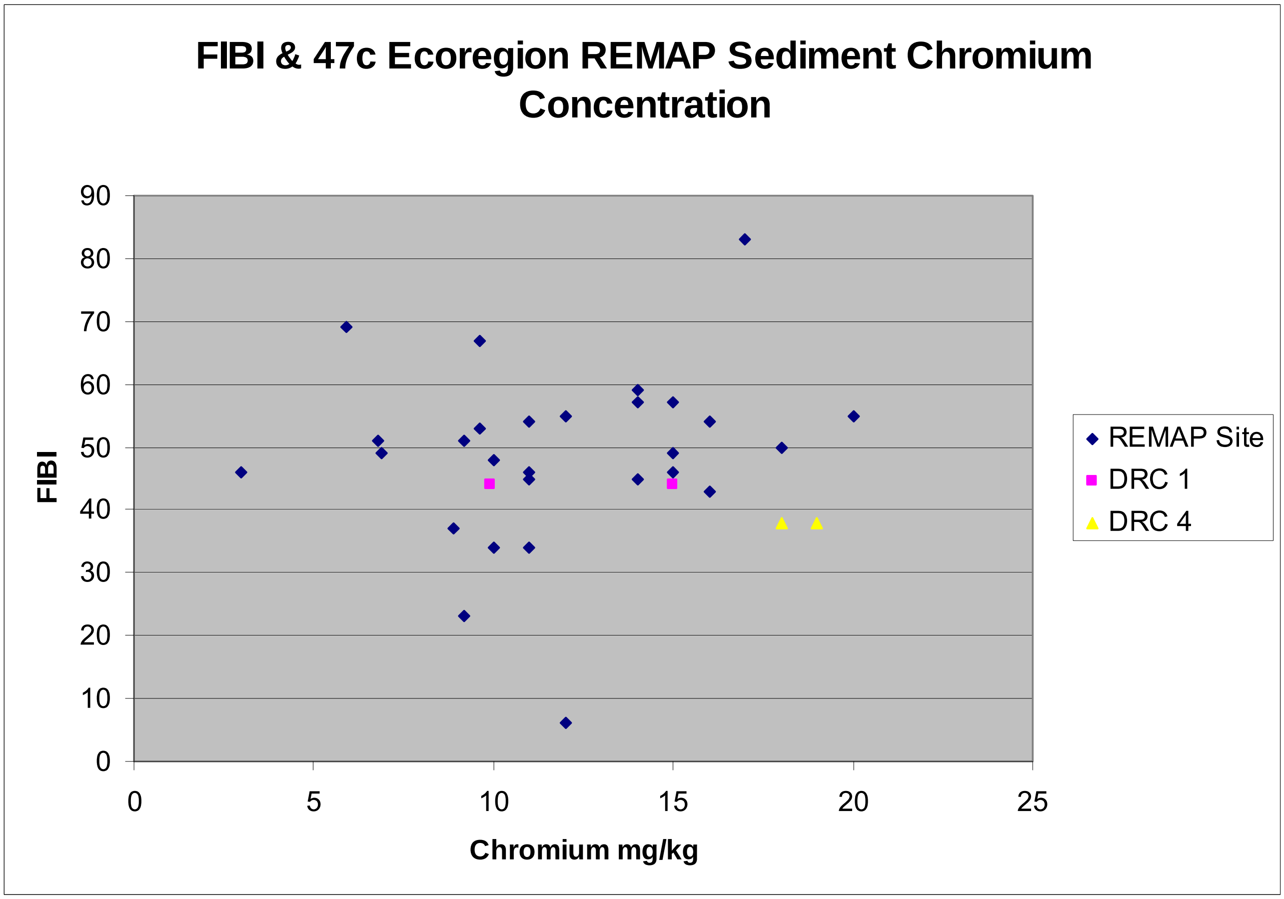


Figure 2-5 47c ecoregion REMAP sediment nickel concentration with associated FIBI & BMIBI Scores



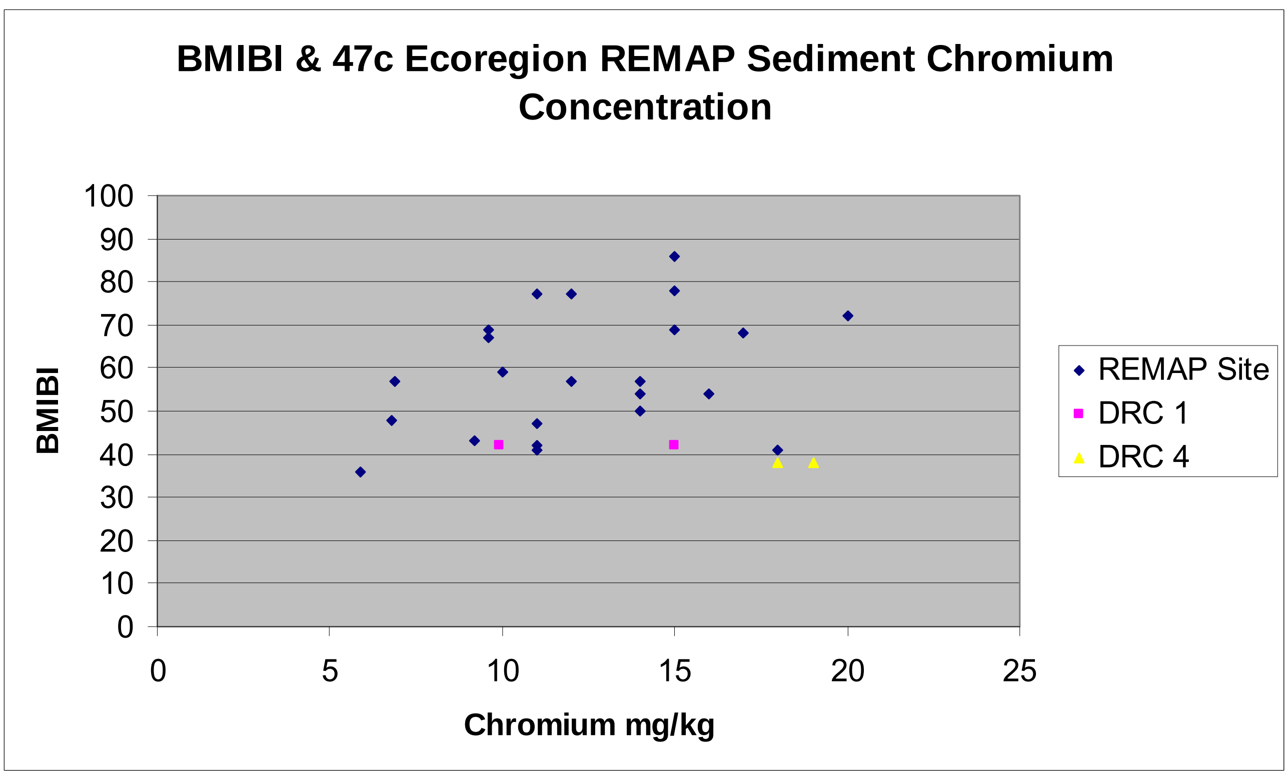
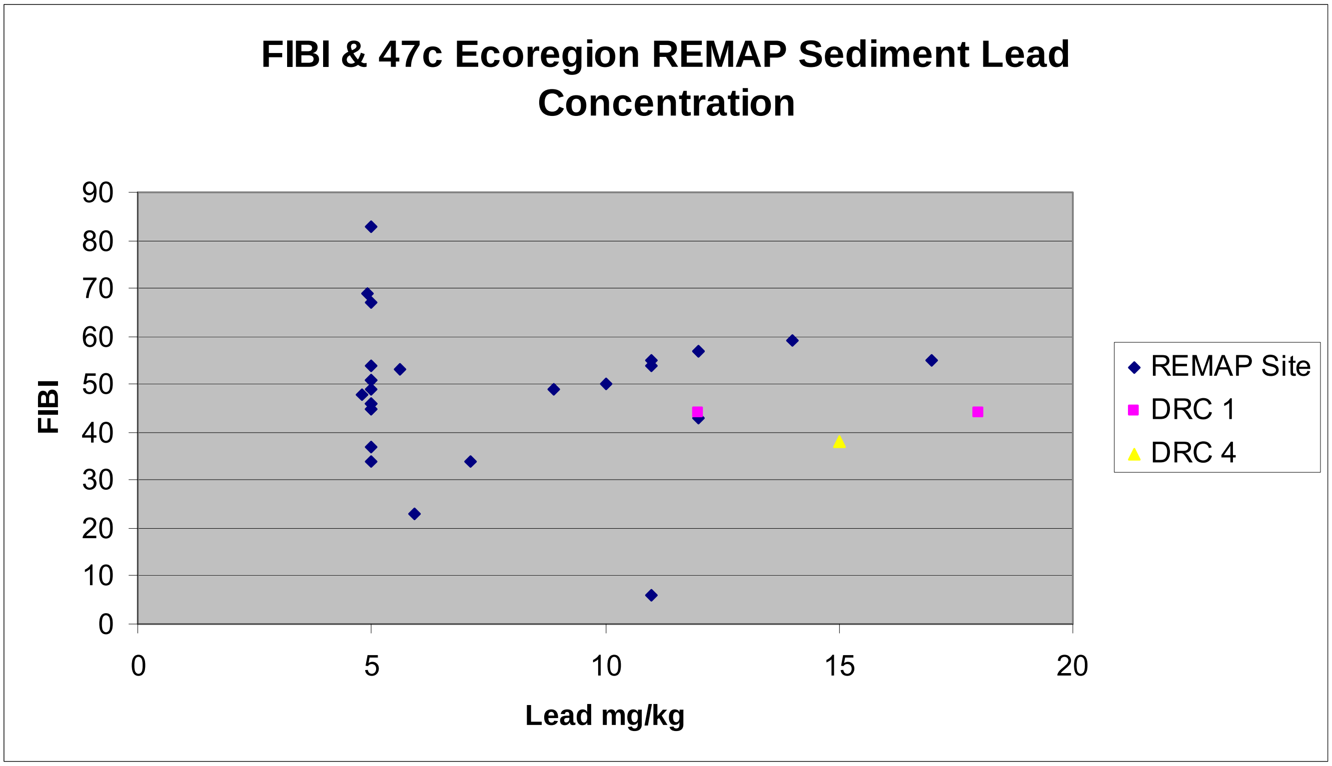


Figure 2-6 47c ecoregion REMAP sediment chromium concentration with associated FIBI & BMIBI Scores



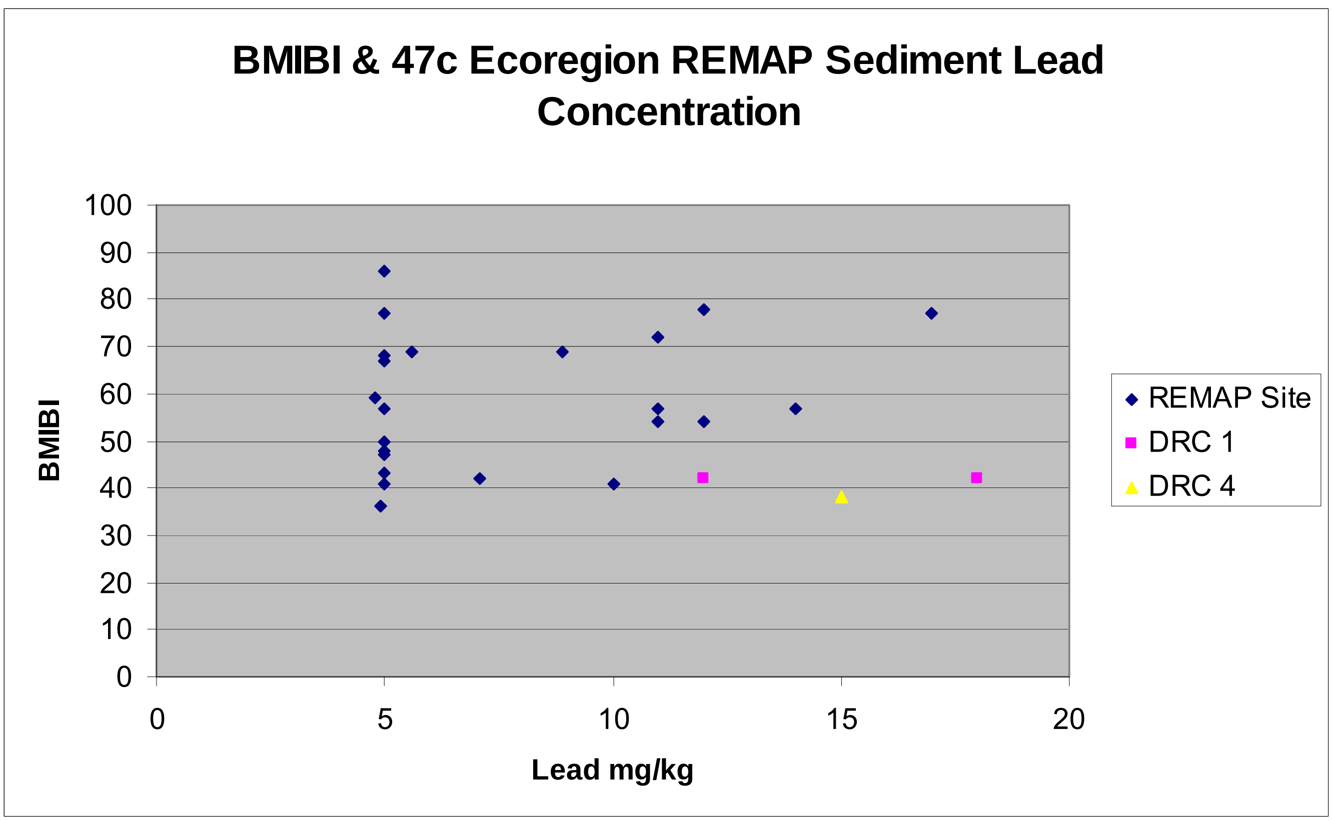
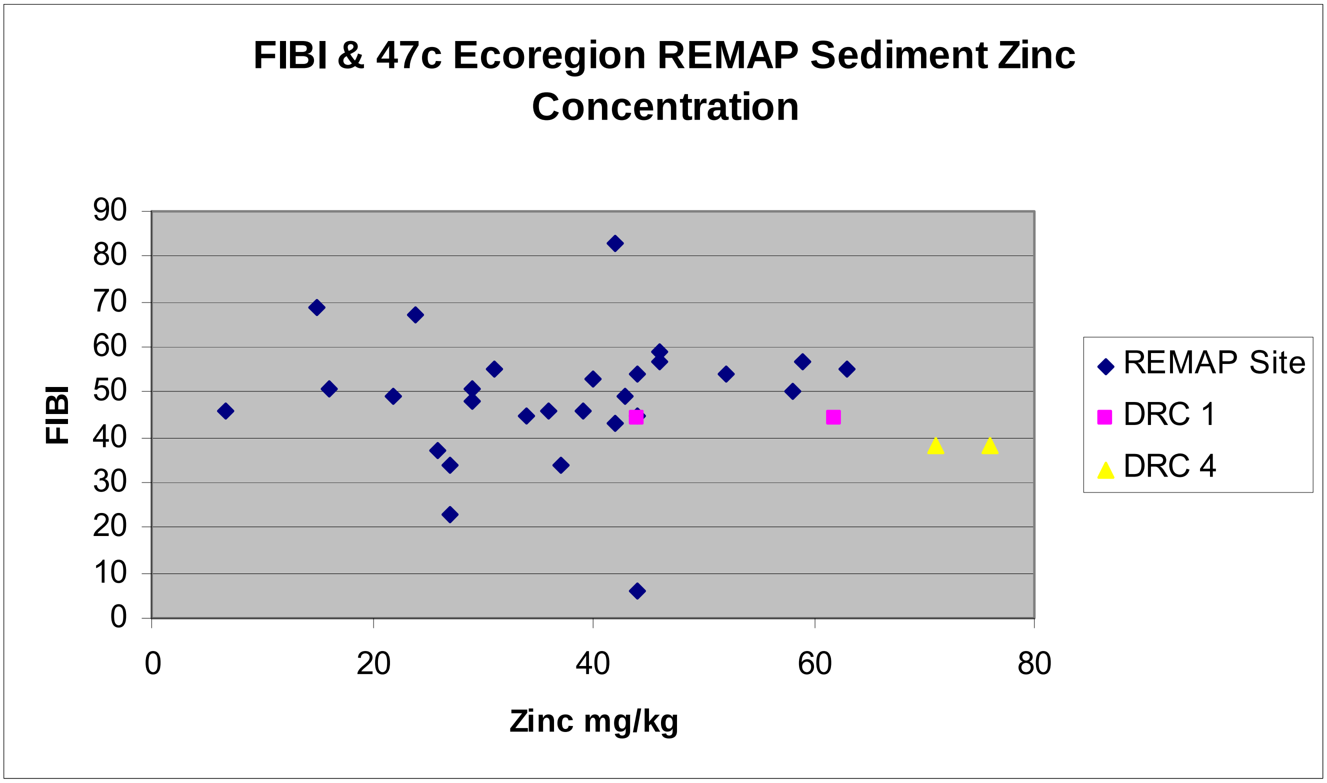


Figure 2-7 47c ecoregion REMAP sediment lead concentration with associated FIBI & BMIBI Scores



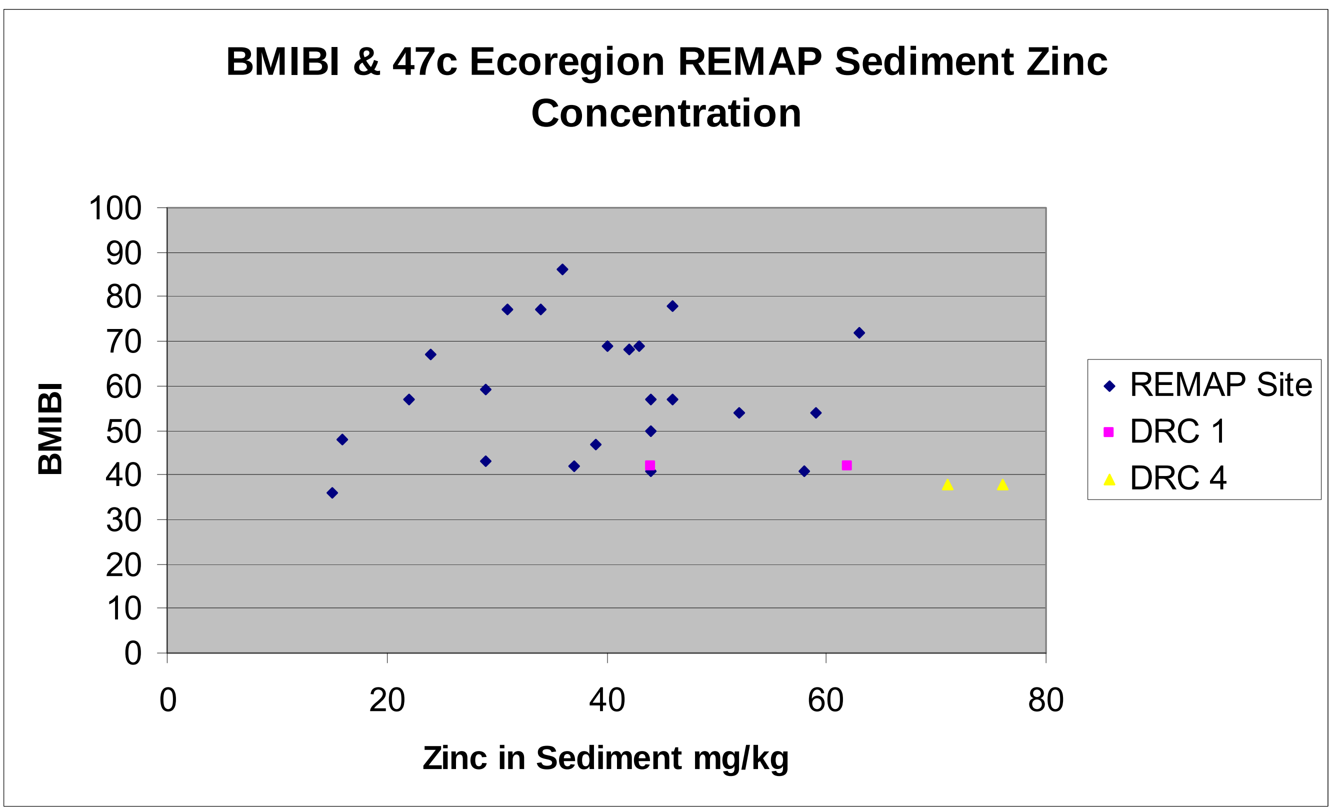


Figure 2-8 47c ecoregion REMAP sediment zinc concentration with associated FIBI & BMIBI Scores

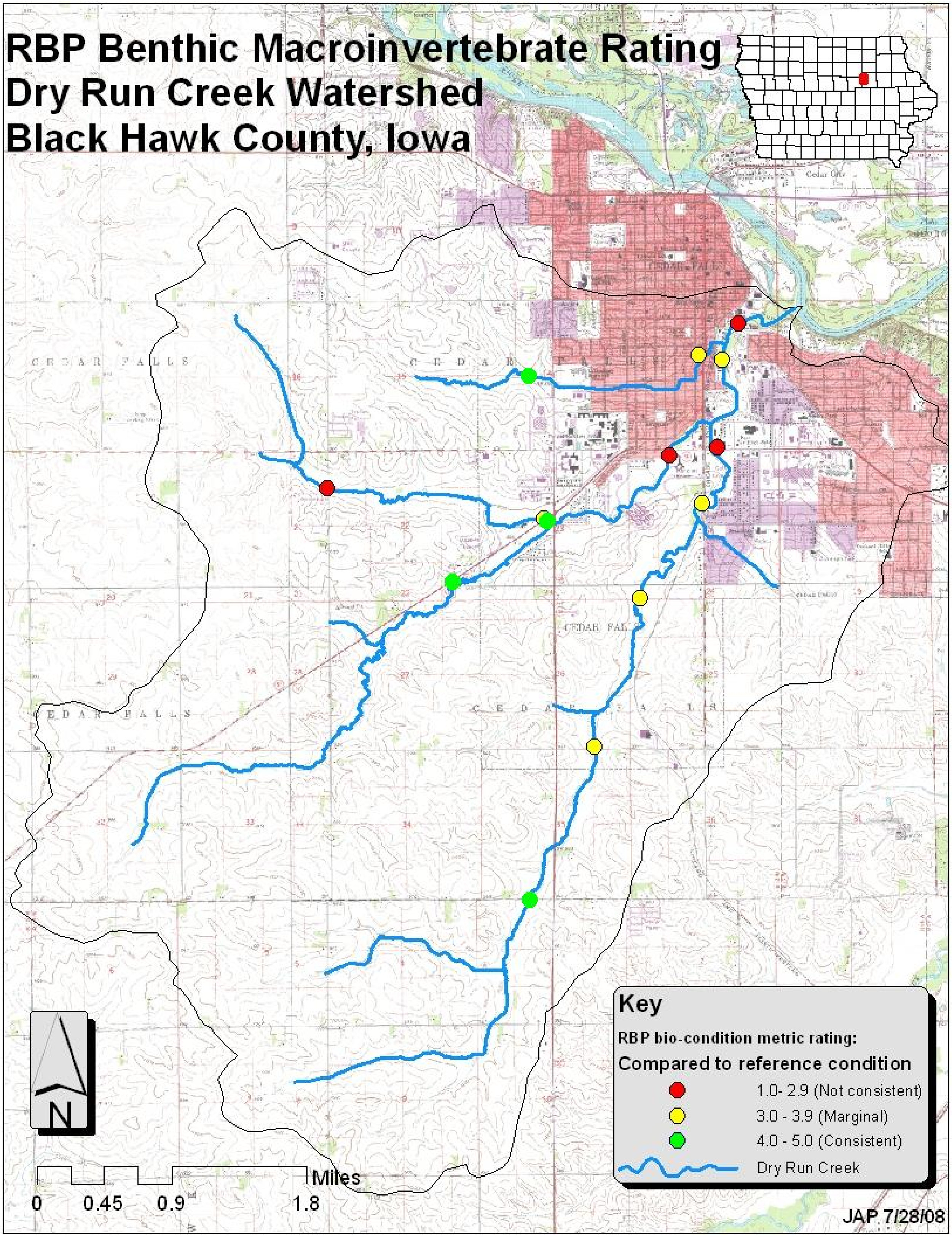


Figure 2-9 Benthic Macroinvertebrate RBP Ranking map

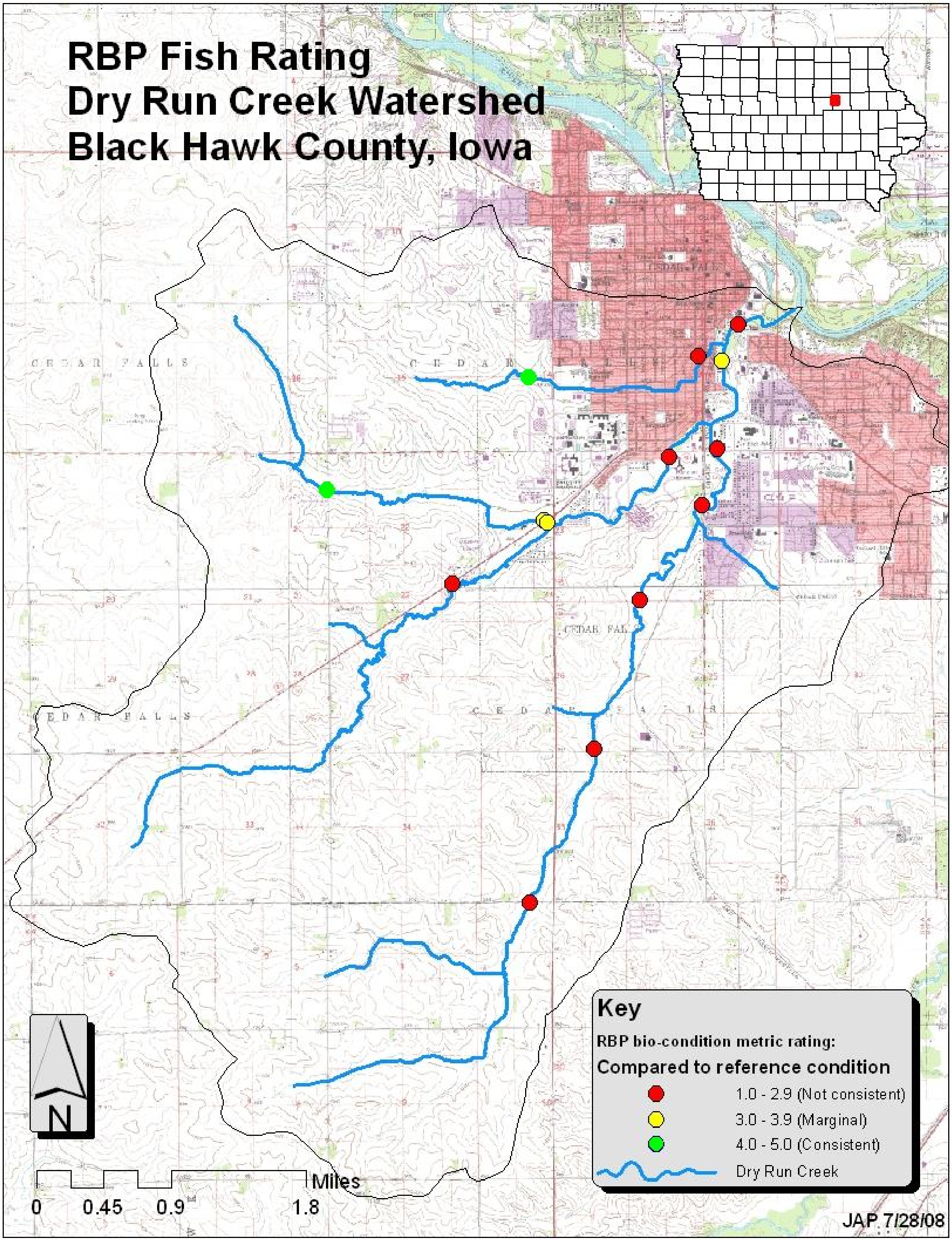


Figure 2-10 Fish RBP Ranking Map

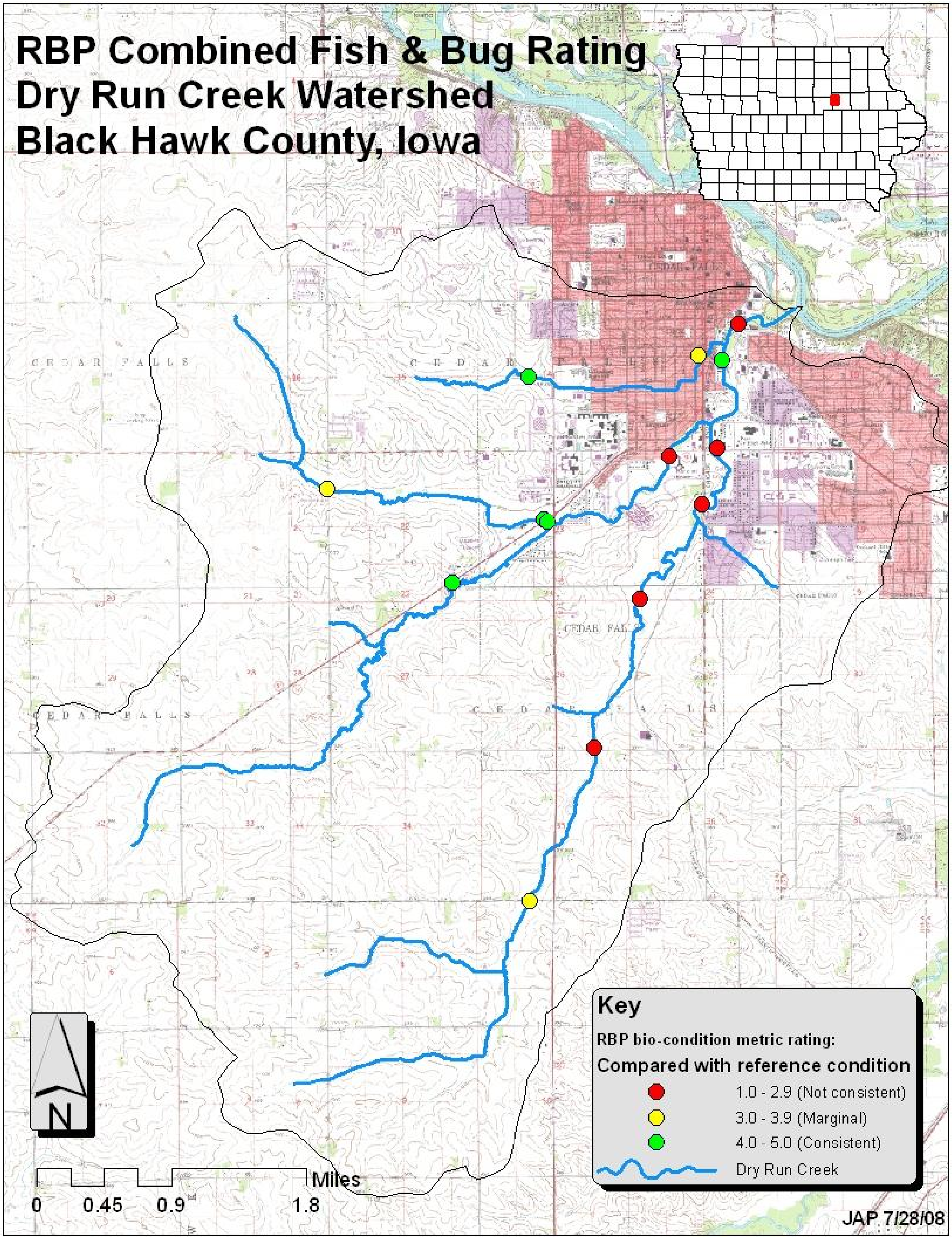


Figure 2-11 Fish and Benthic Macroinvertebrate Combination Ranking Map

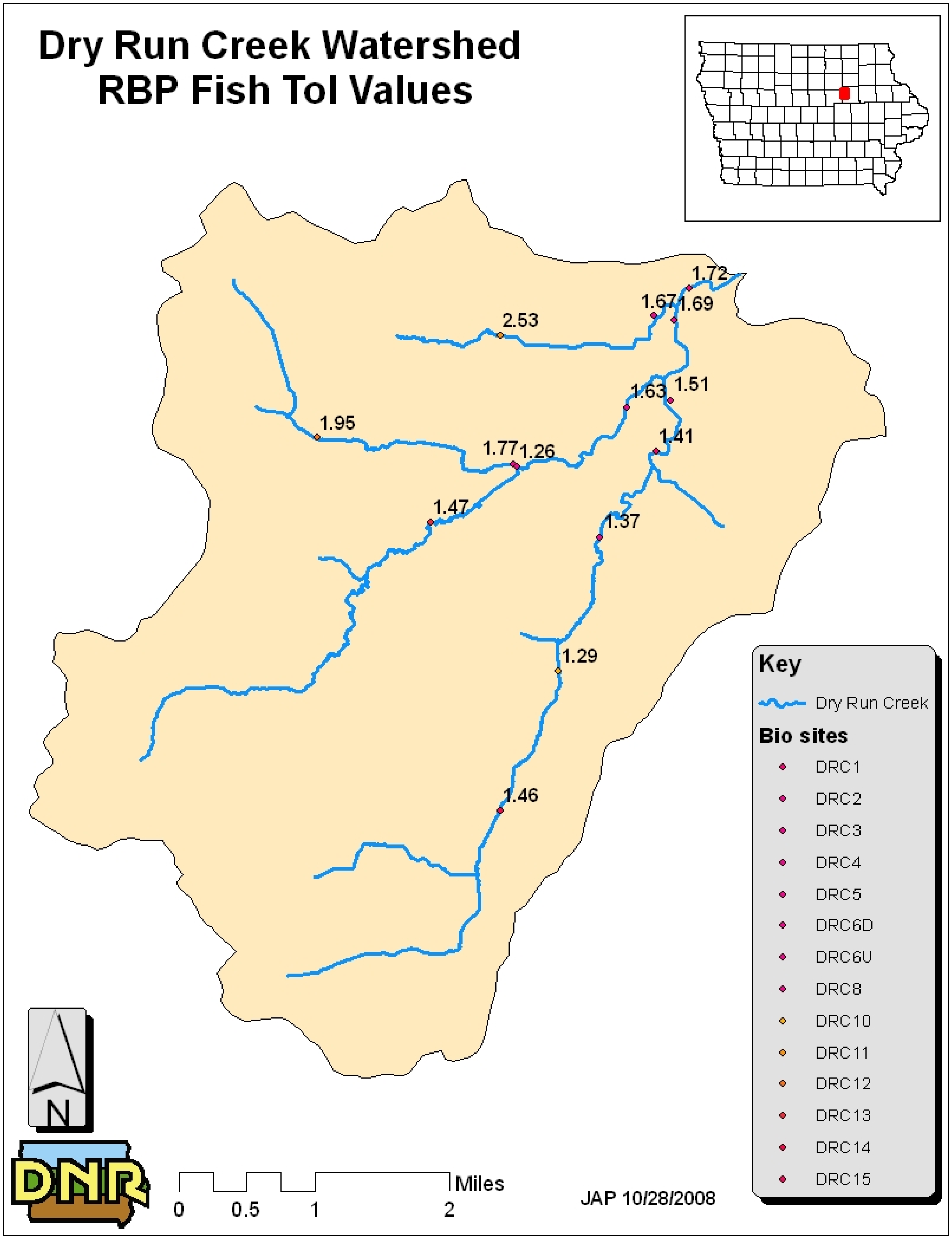


Figure 2-12 RBP Fish Tolerance Values
RBP fish tol value rankings: 1 (most tolerant) – 3 (least tolerant)

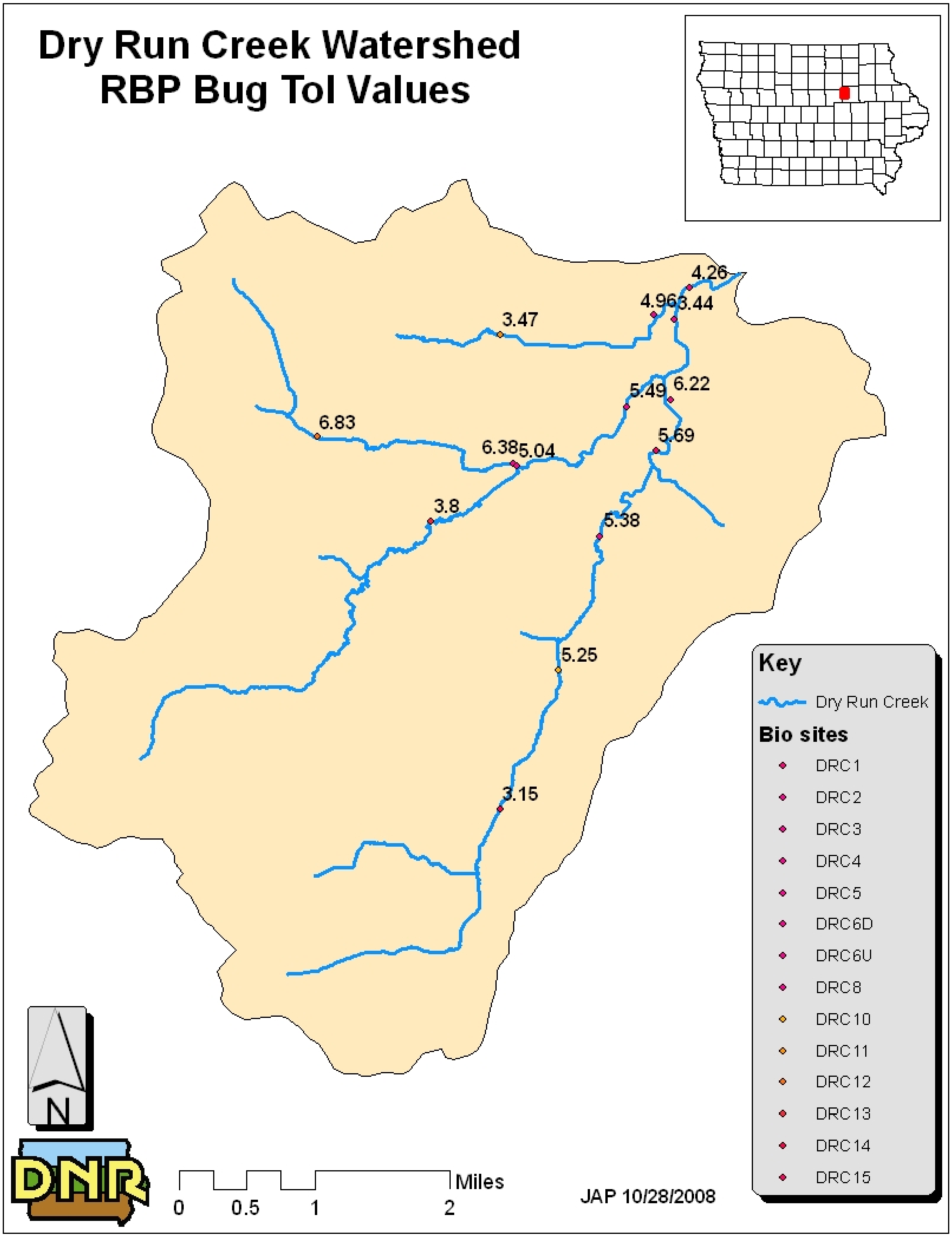


Figure 2-13 RBP Bug Tolerance Values
RBP bug tol value rankings: 1 (least tolerant) – 10 (most tolerant

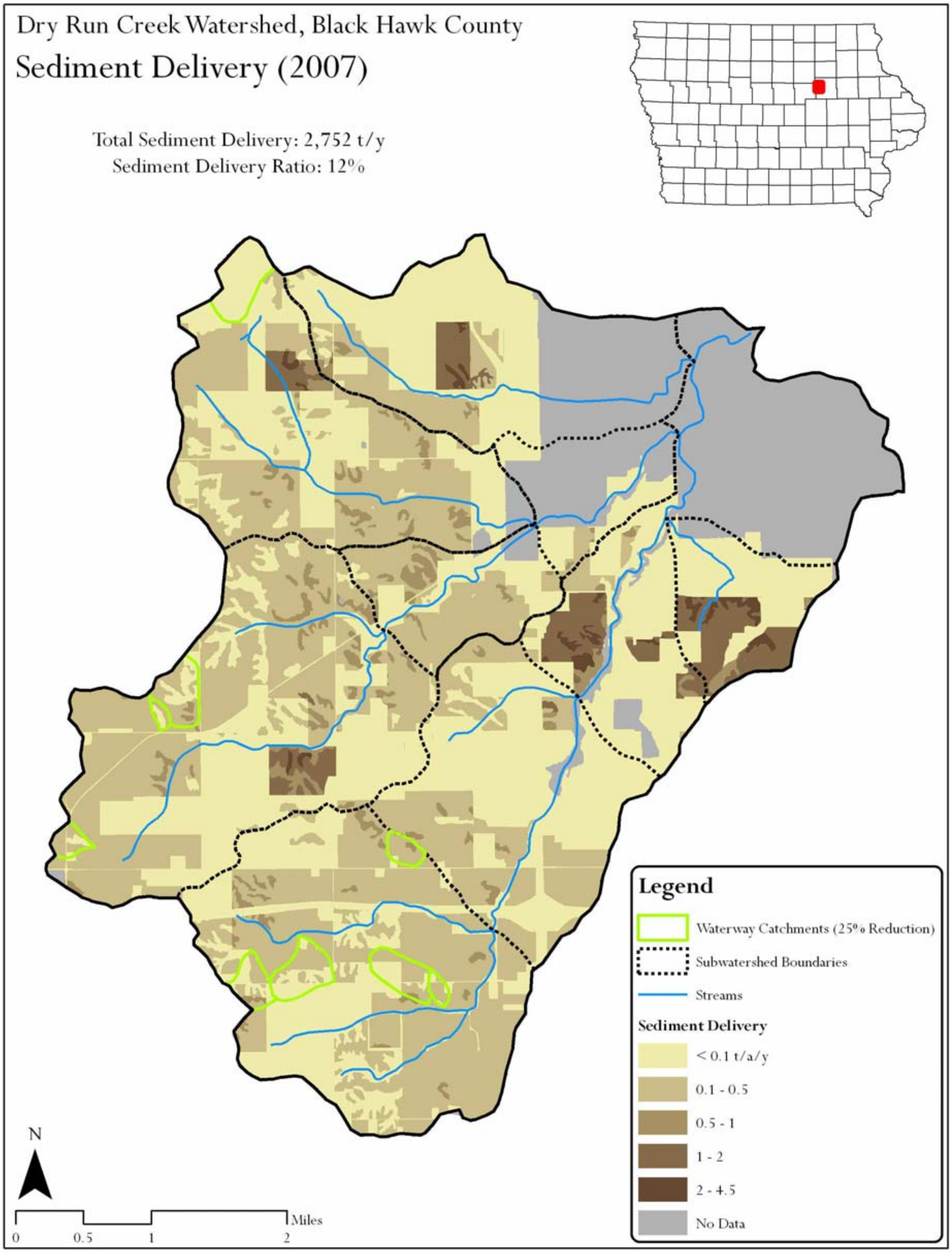


Figure 2-14 Dry Run Creek Watershed Soil Loss Map

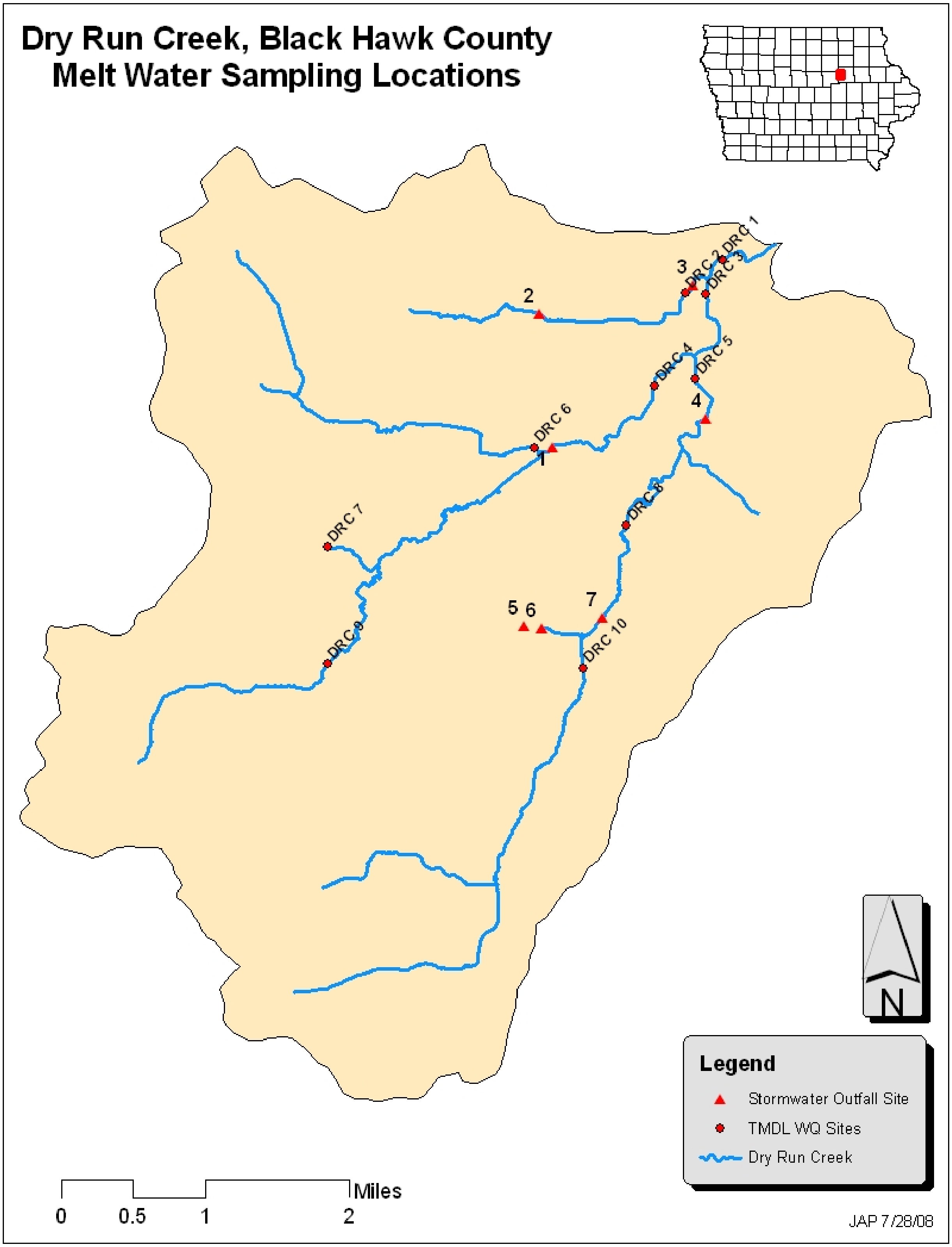


Figure 2-15 Melt Water Sampling Locations

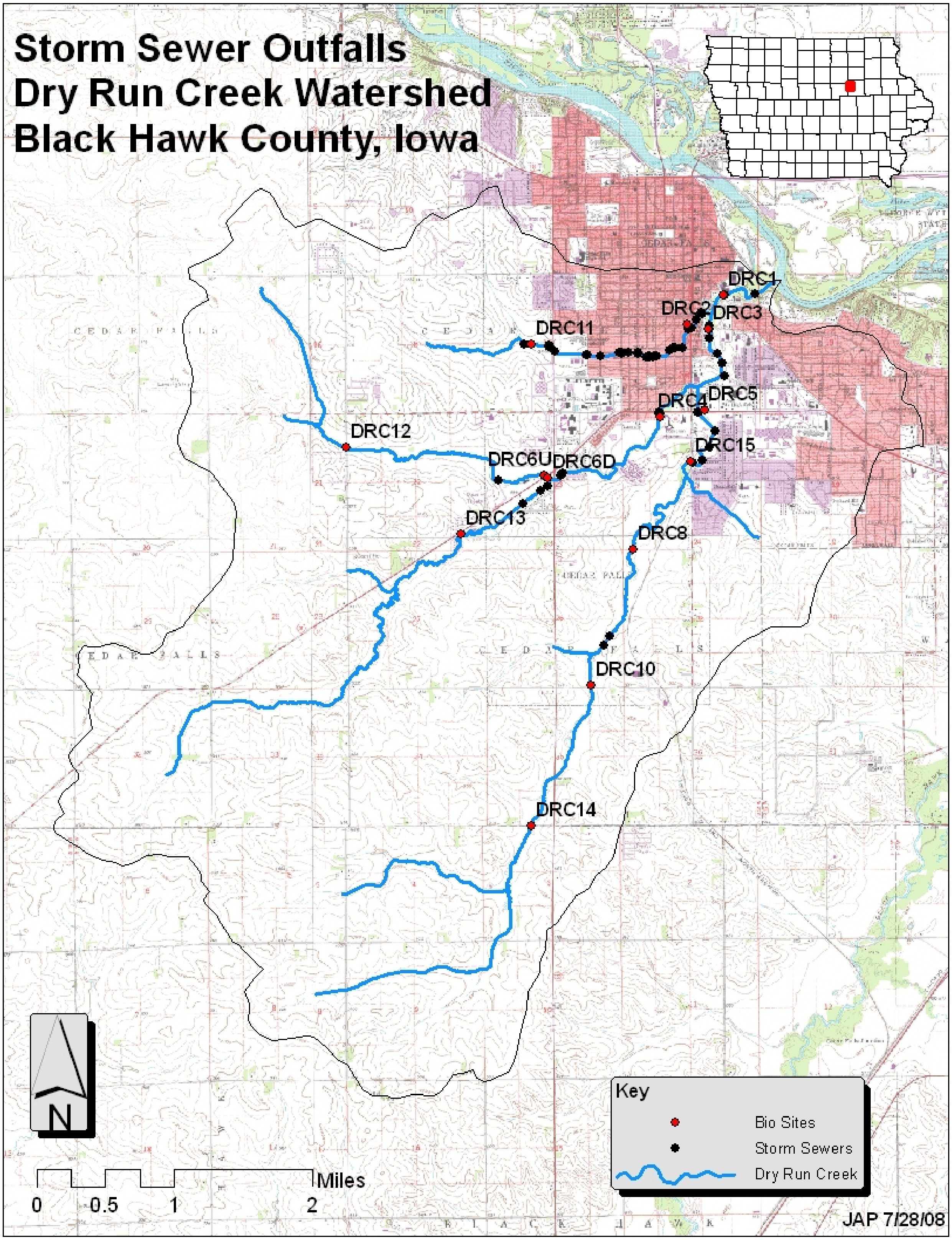


Figure 2-16 Storm Sewer Outfall Locations

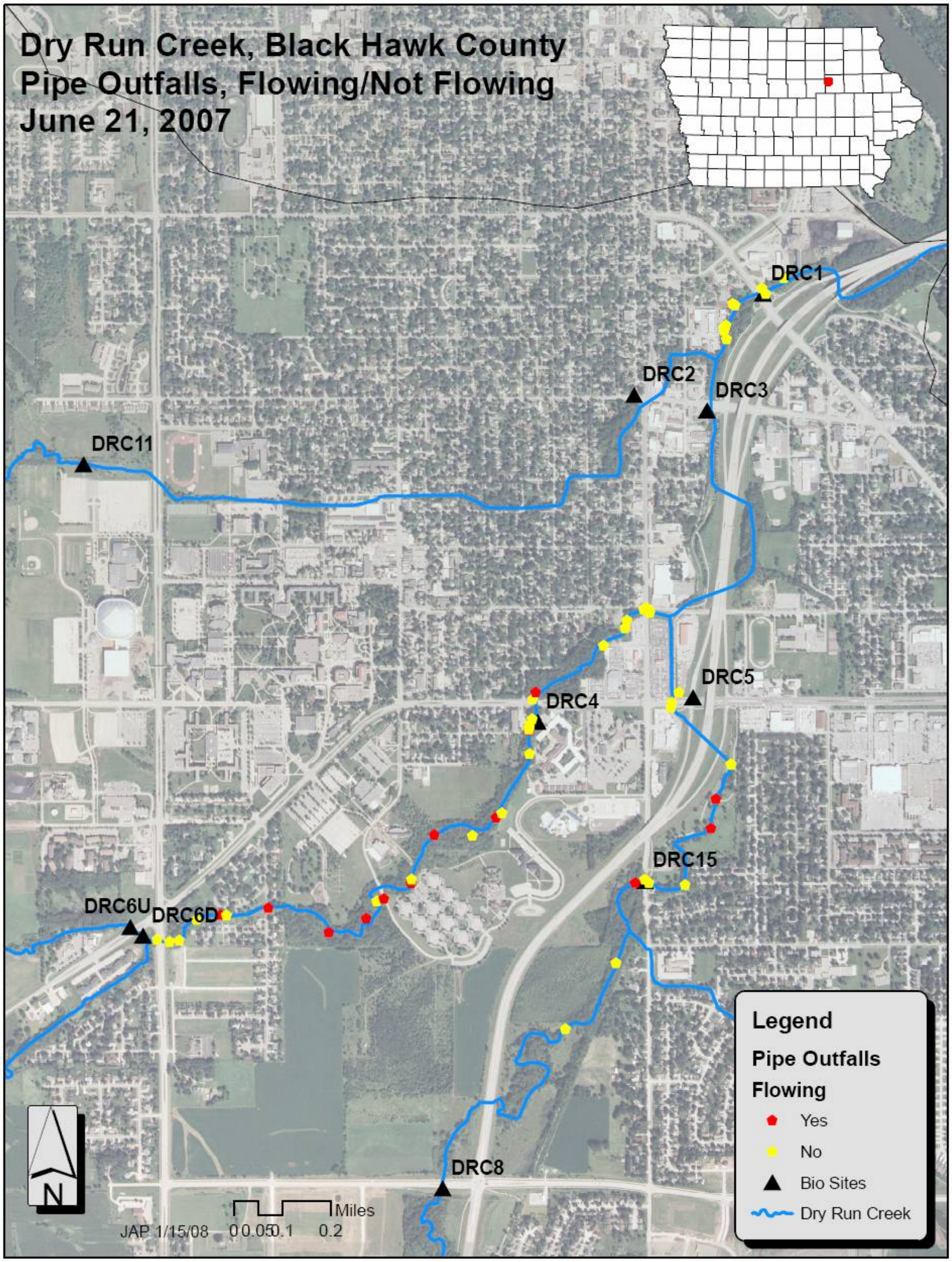


Figure 2-17 Pipe Outfalls Dry Weather, Flowing Vs. Not Flowing

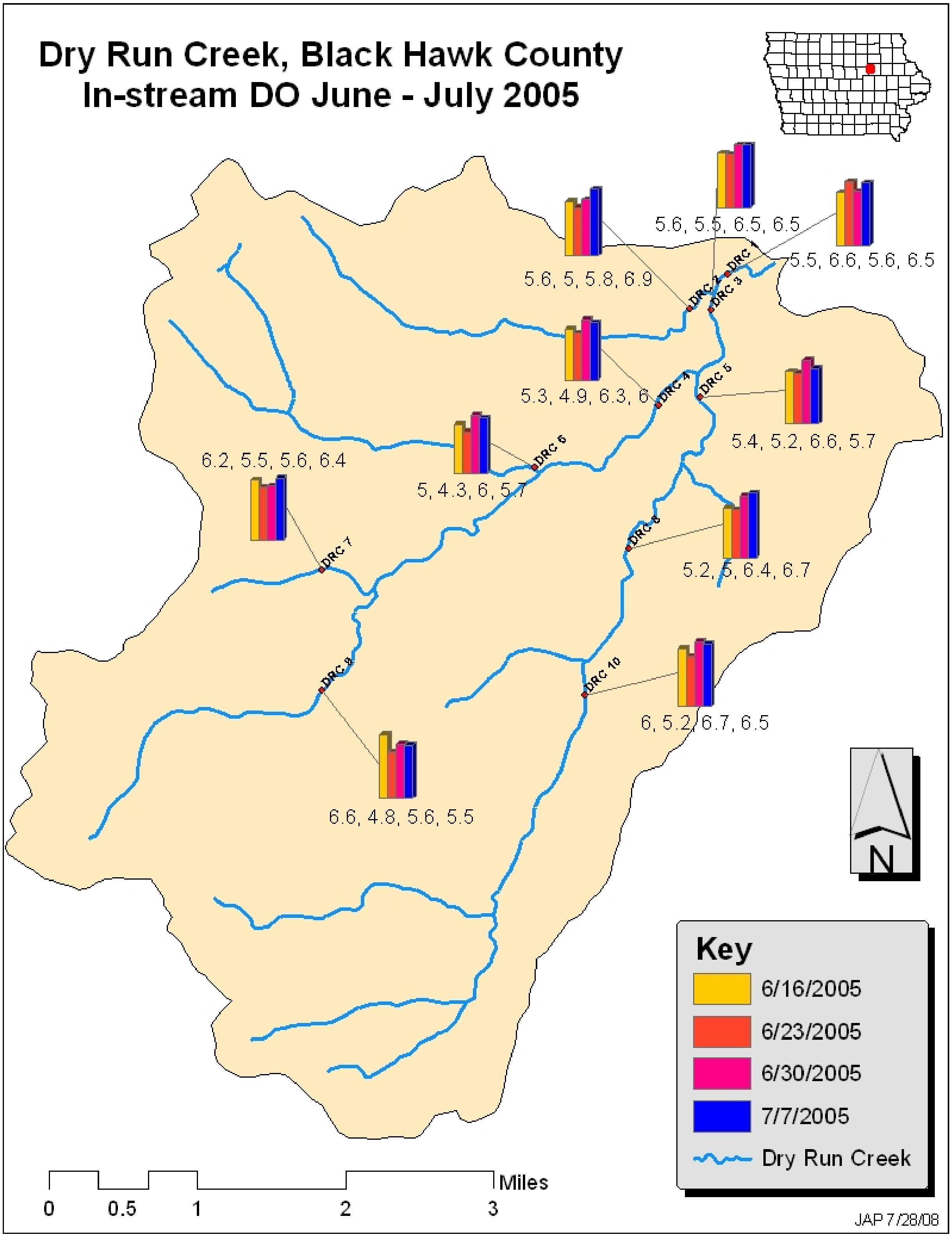


Figure 2-18 In-stream Dissolved Oxygen Concentrations June-July 2005

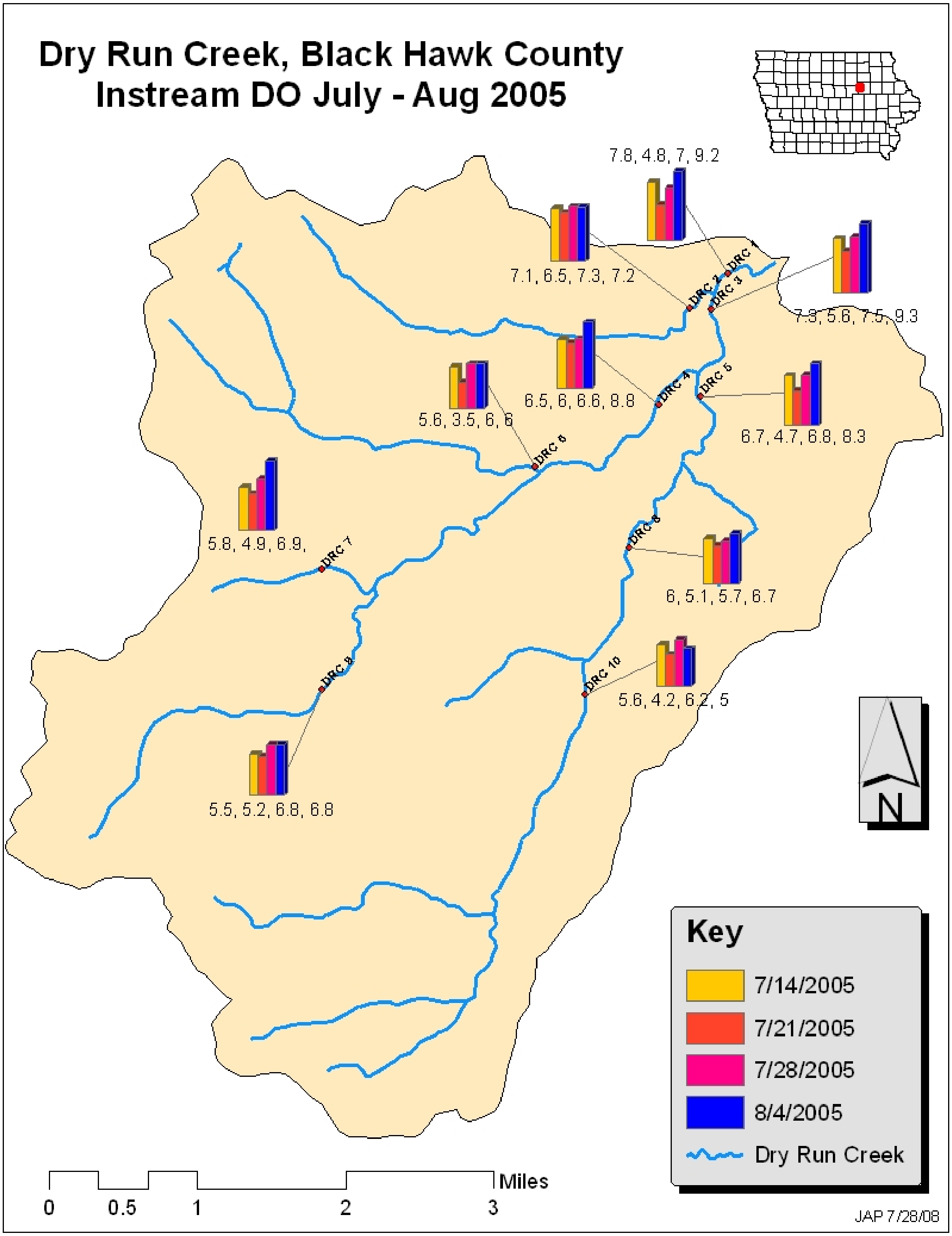


Figure 2-19 In-stream Dissolved Oxygen Concentrations July-August 2005

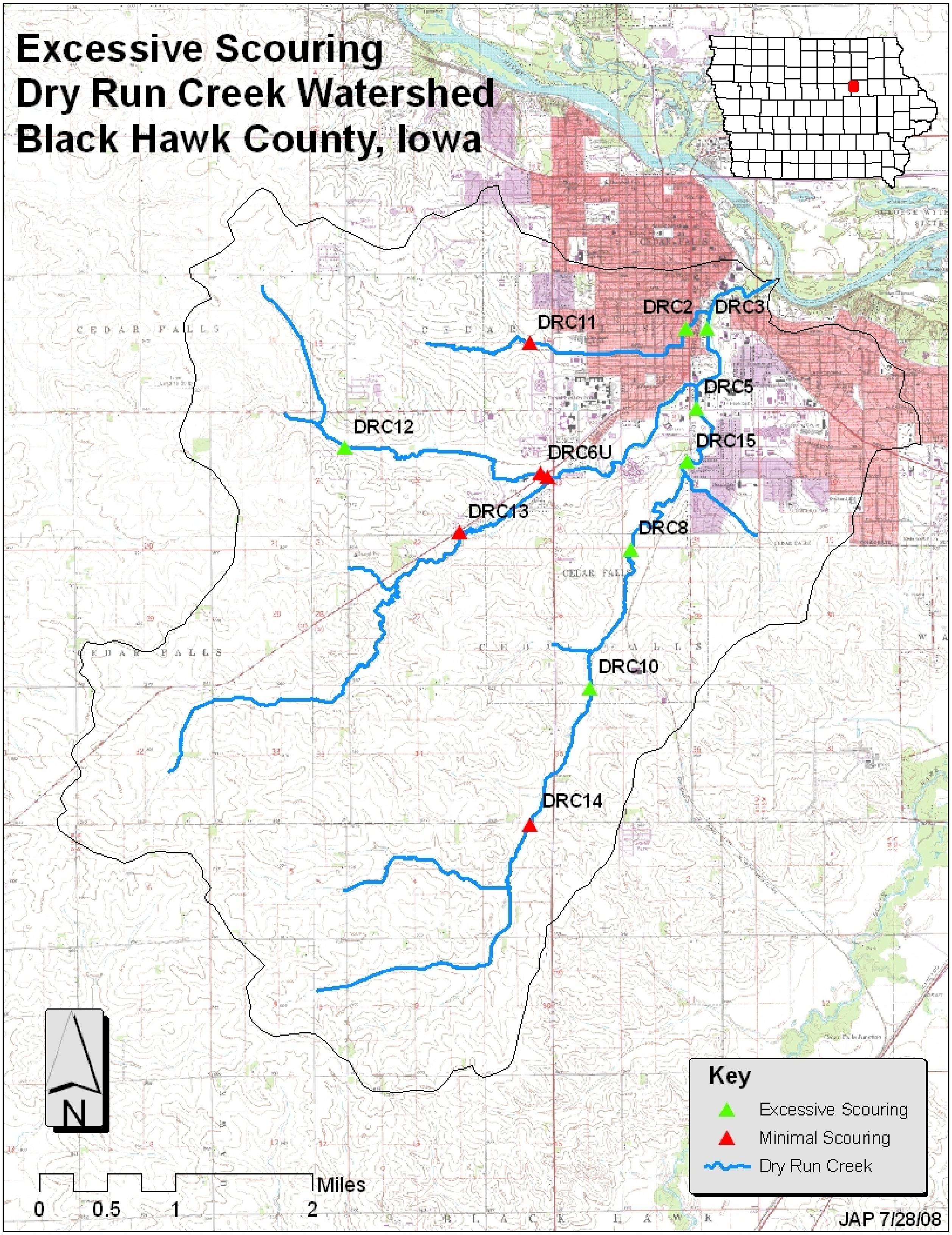


Figure 2-20 Scoured Habitat from RBP SI Habitat Rankings

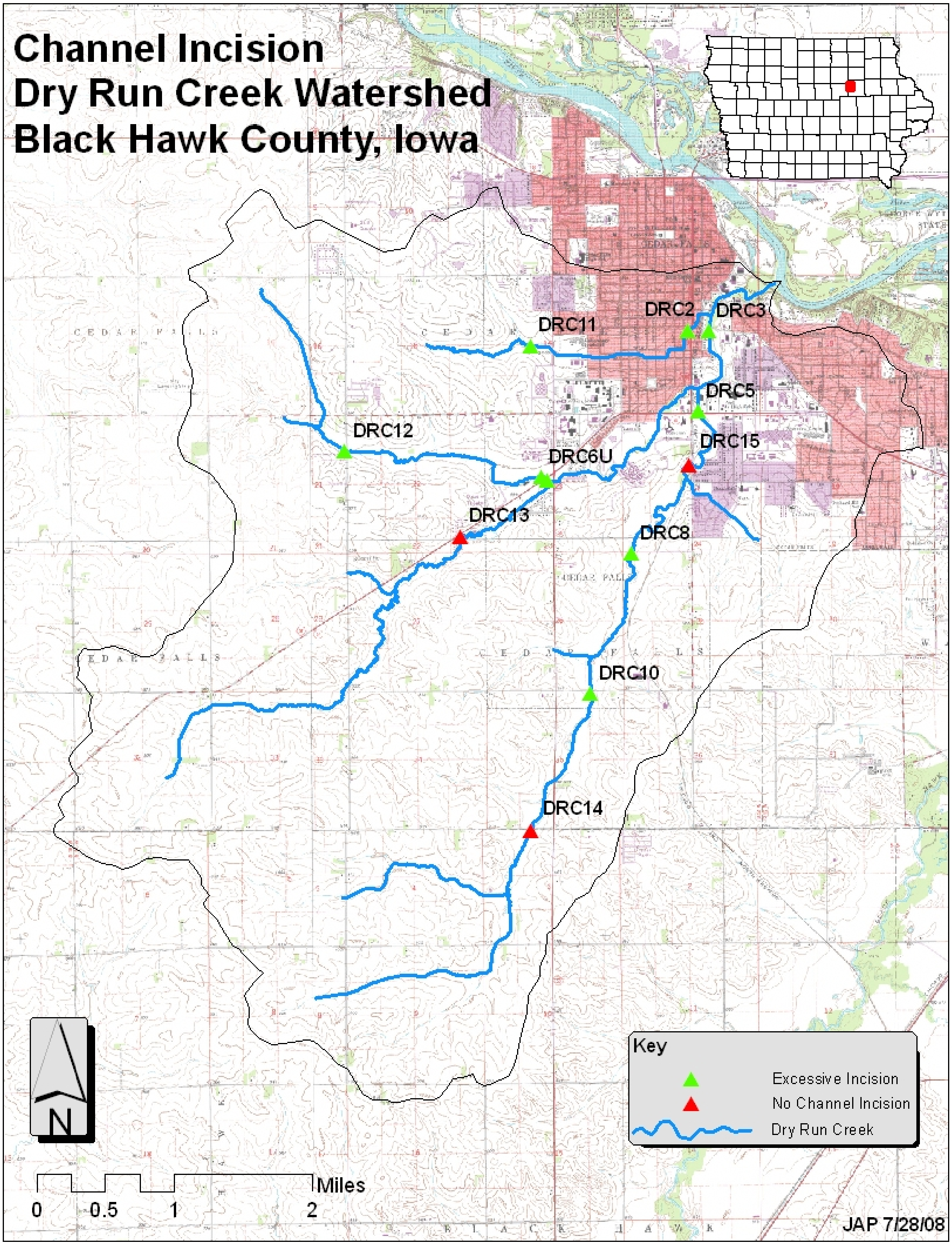


Figure 2-21 Excessive Channel Incision RBP Sites

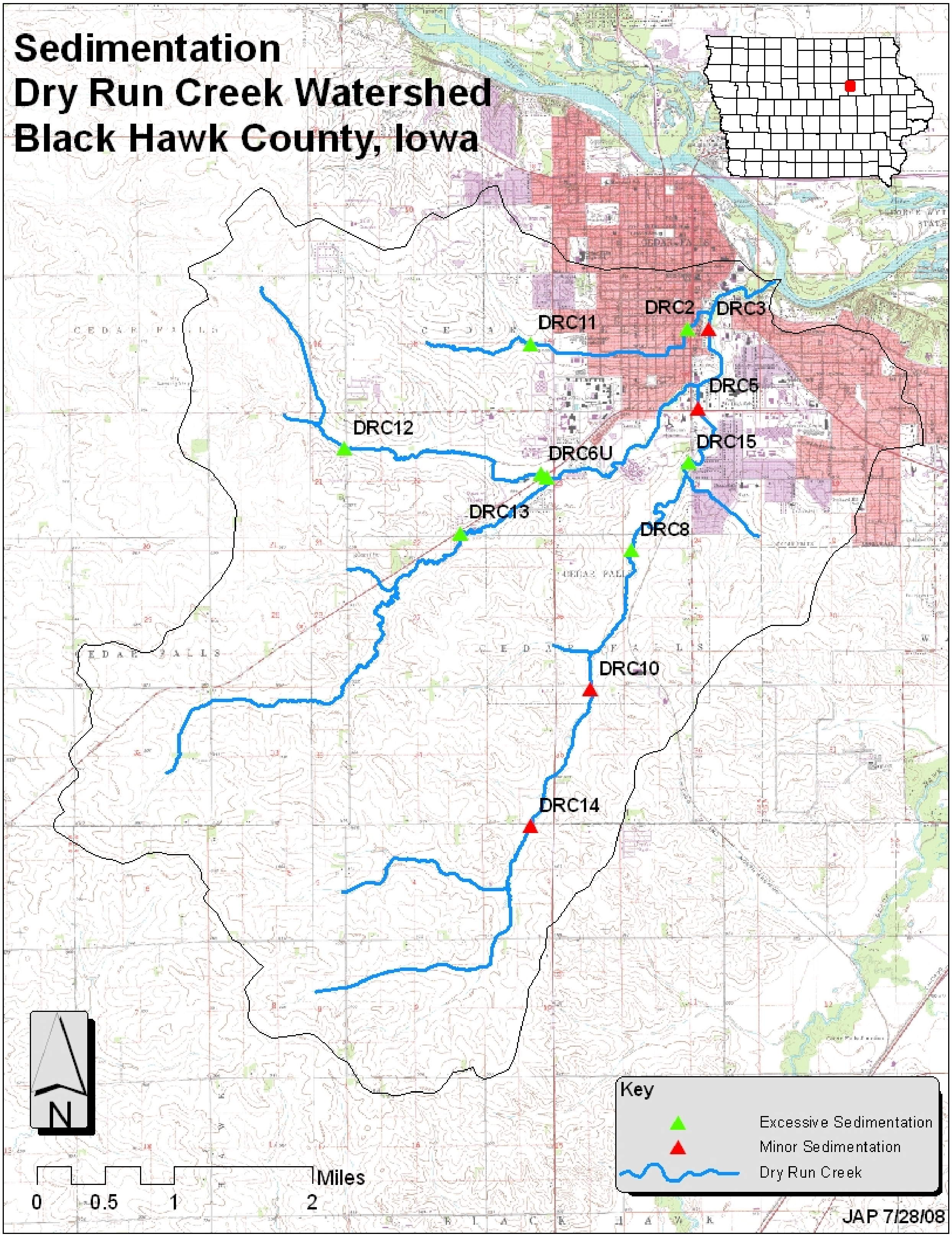


Figure 2-22 Excessive Sedimentation RBP Sites

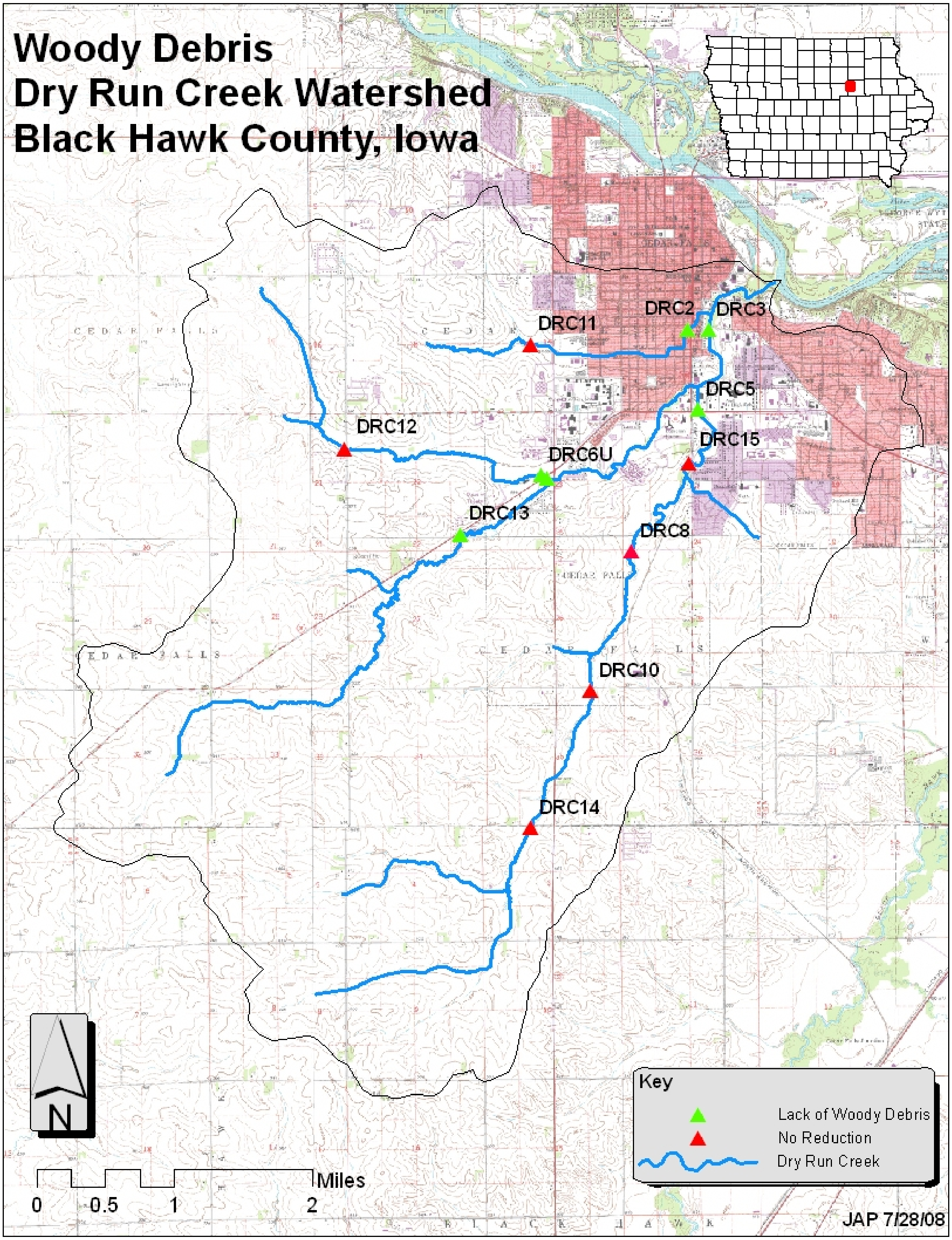


Figure 2-23 Woody Debris Rankings RBP Sites

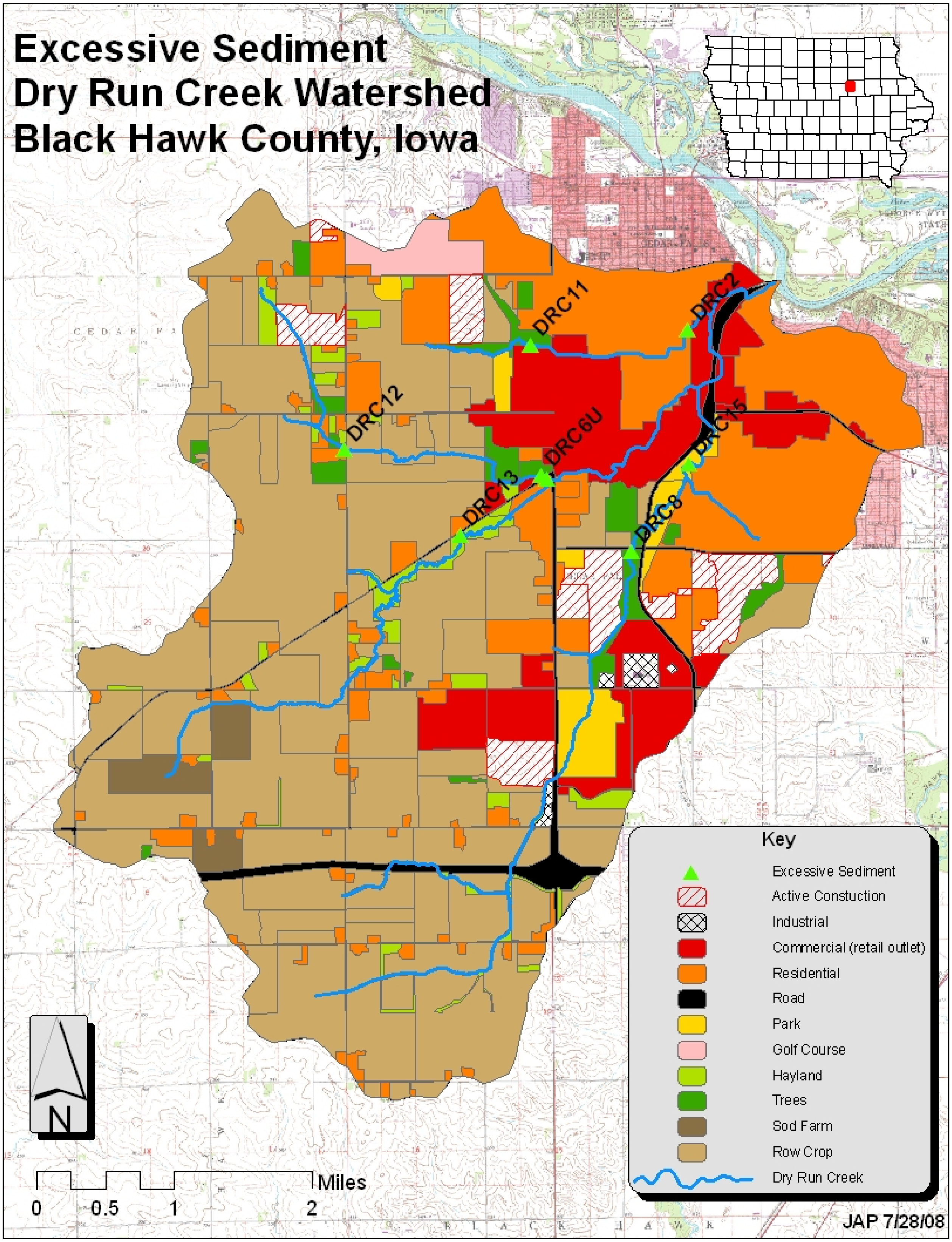


Figure 2-24 Excessive Sediment Deposition, RBP Sites

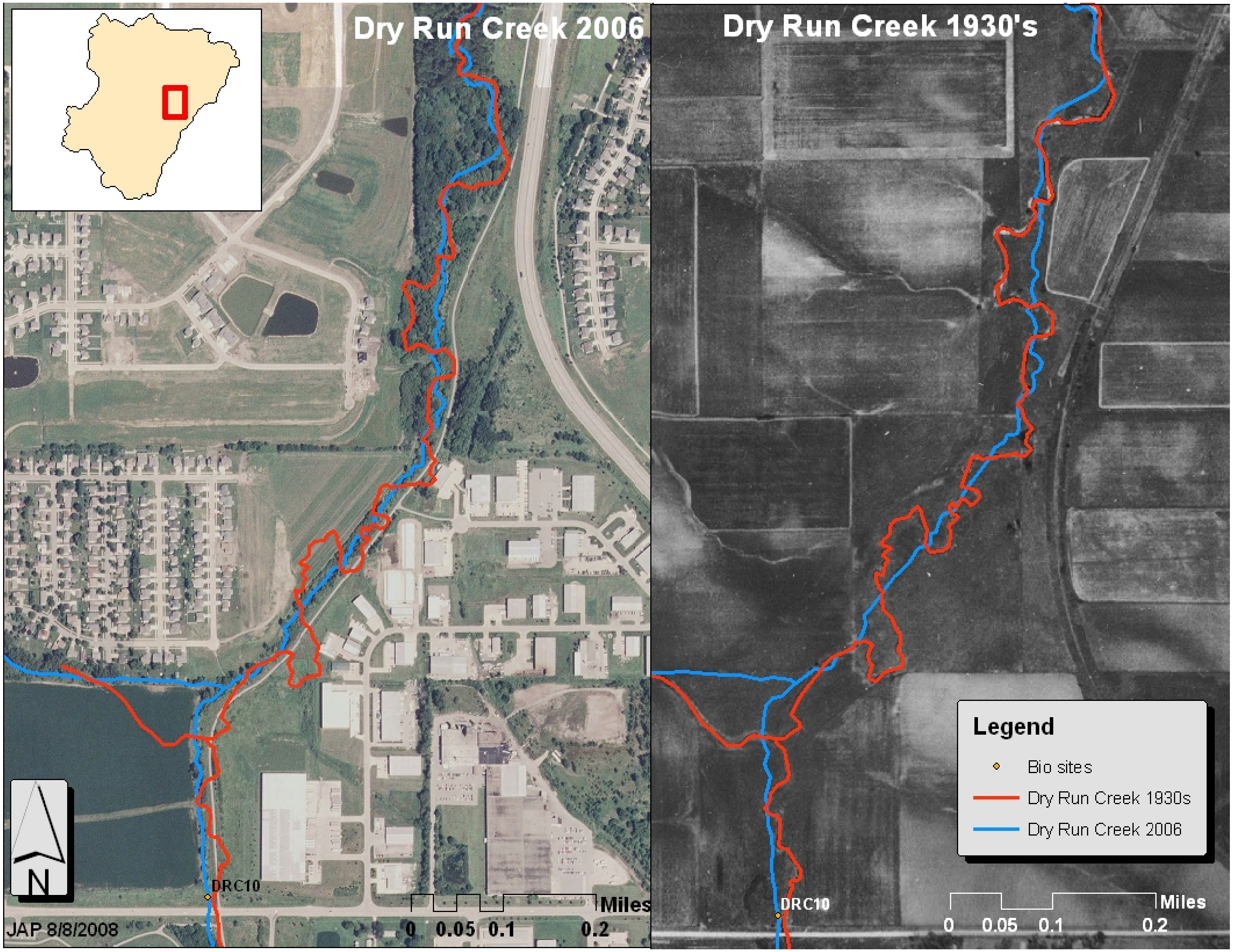


Figure 2-25 Past and Present day Channel Comparison

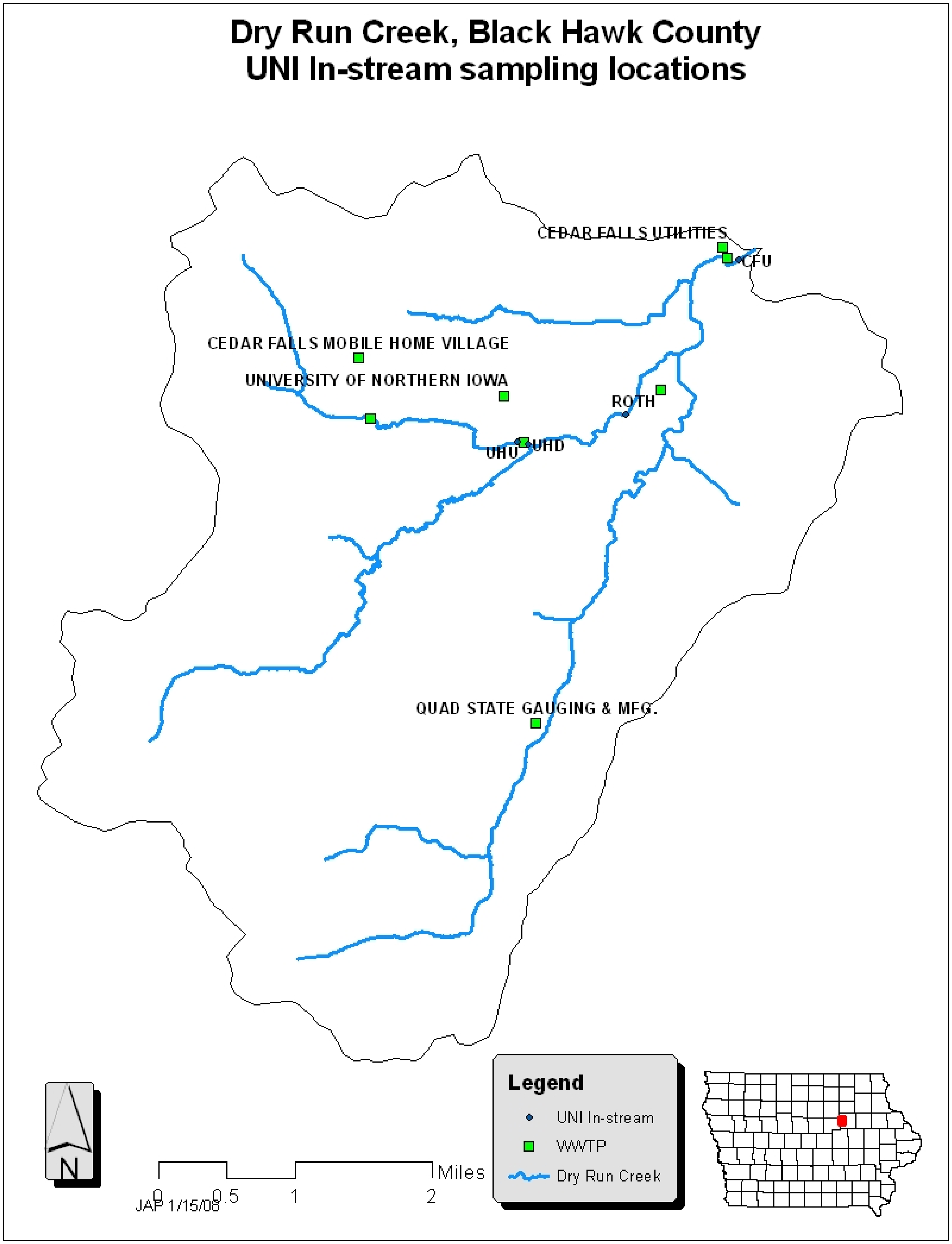


Figure 2-26 UNI Study In-stream sites

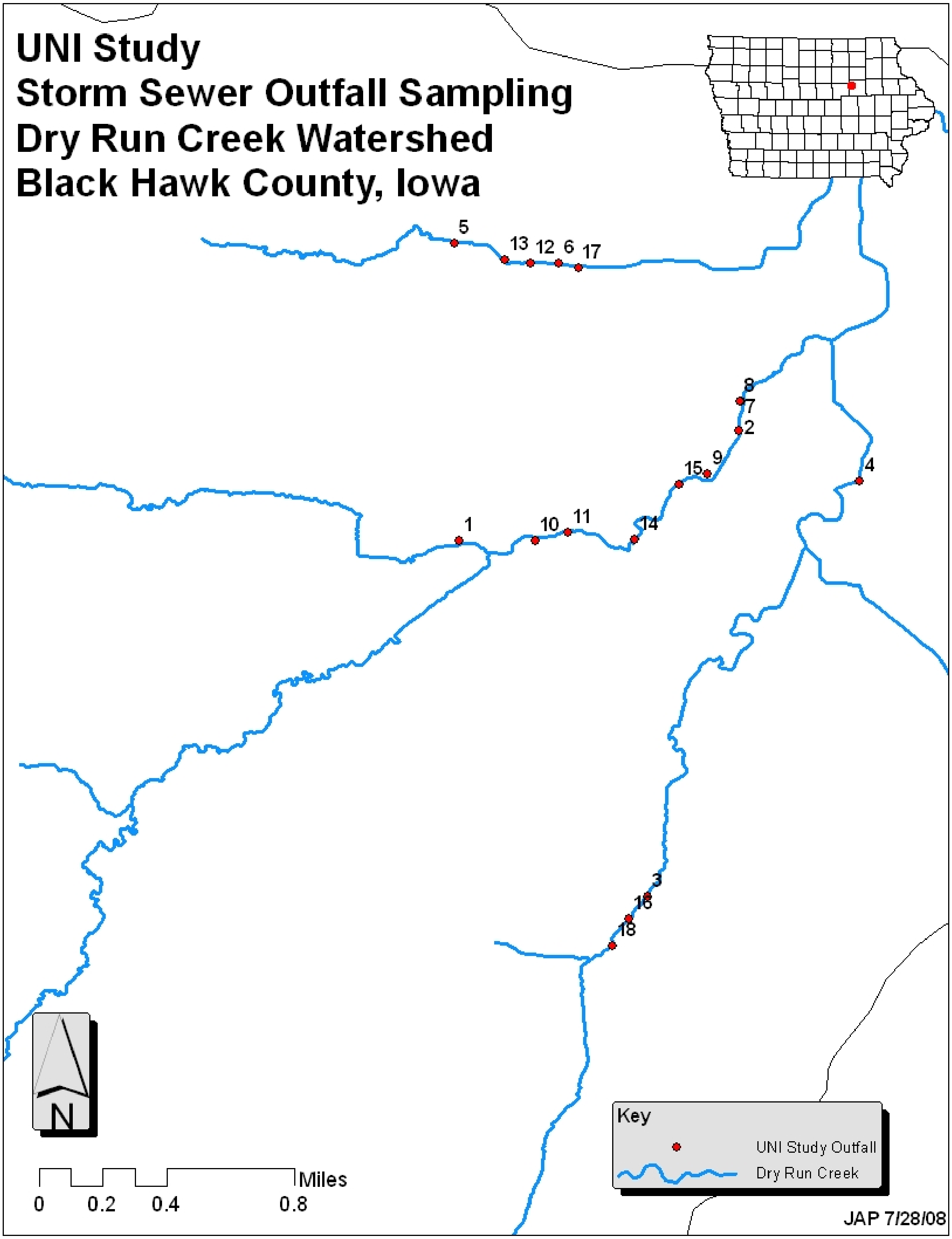


Figure 2-27 UNI Study Outfall Sampling Locations

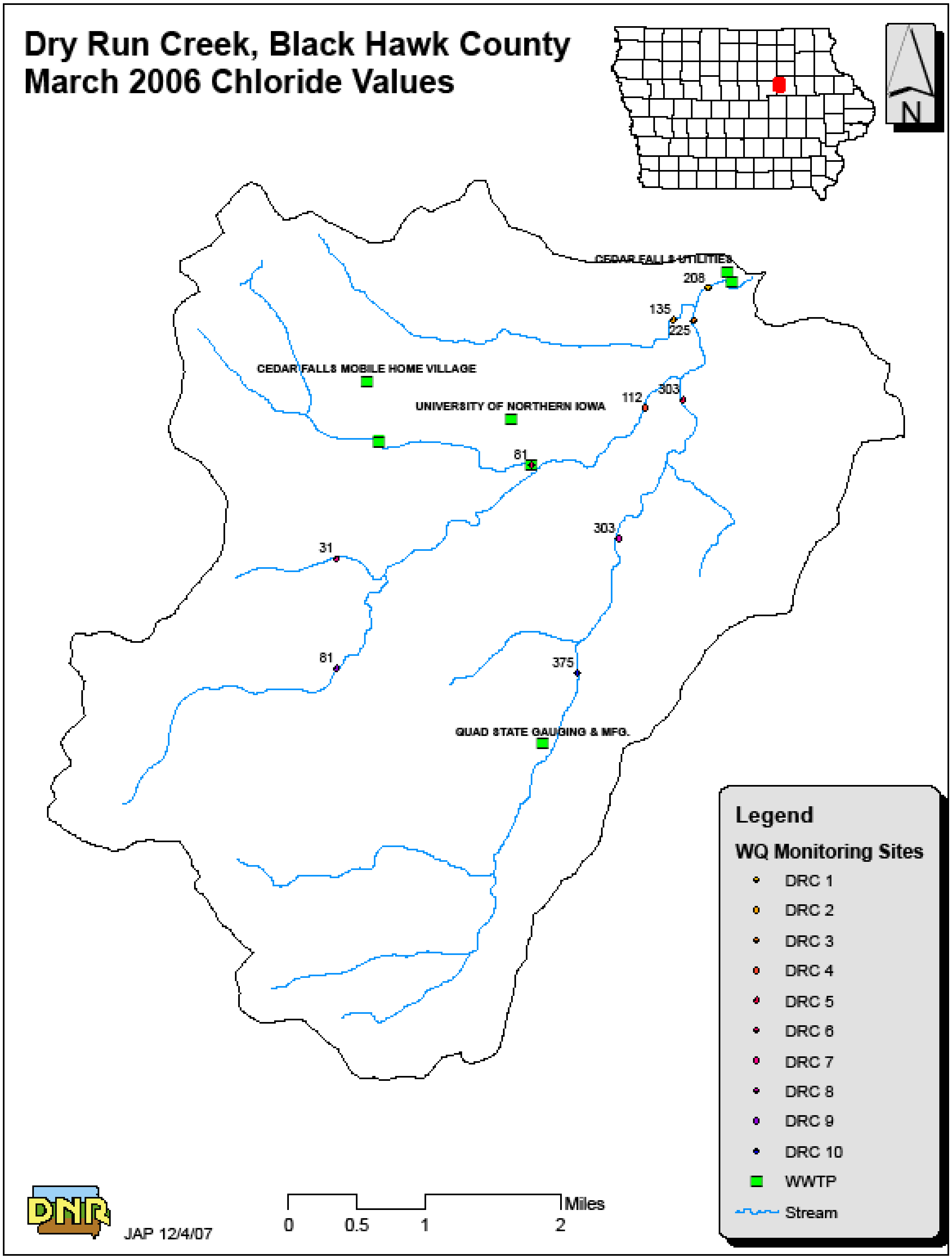


Figure 2-28 March 2006 Bi-weekly Sampling Chloride Values

Third Appendix: Conceptual Models

Conceptual Models of Plausible Causal Pathways

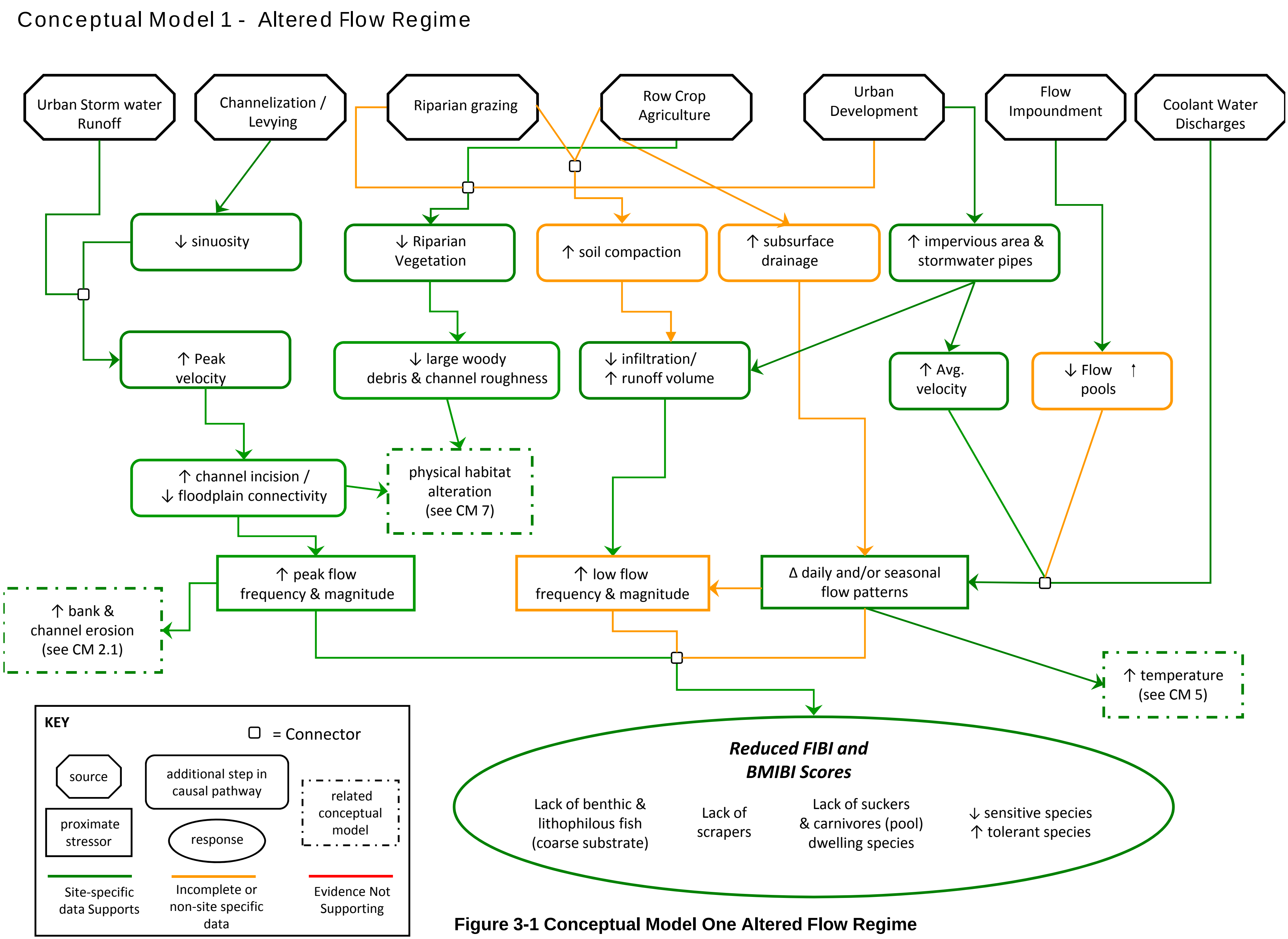


Figure 3-1 Conceptual Model One Altered Flow Regime

Conceptual Model 2.1 - Suspended and Bedded Sediments (SABS)

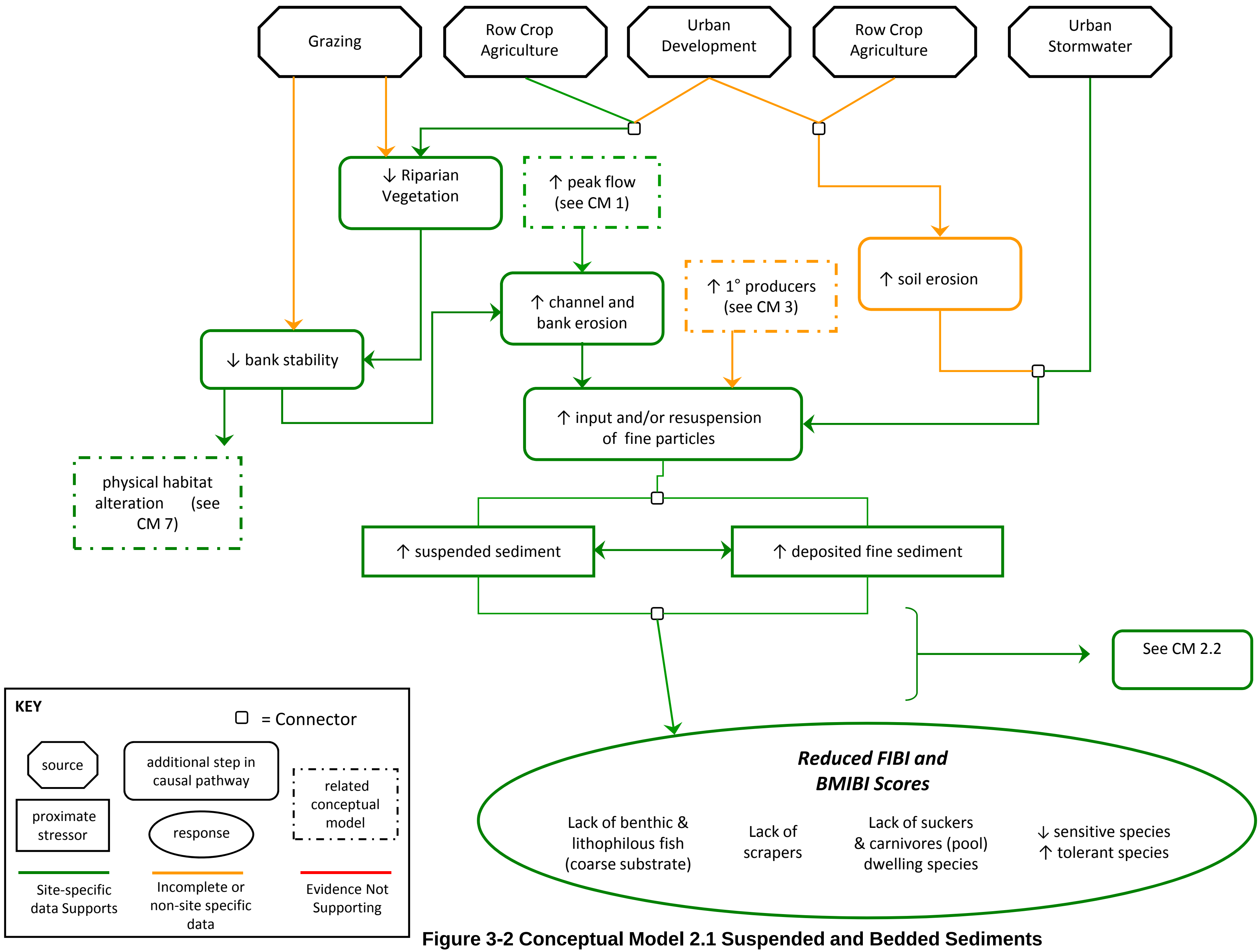


Figure 3-2 Conceptual Model 2.1 Suspended and Bedded Sediments

Conceptual Model 2.2 - Suspended and Bedded Sediments (SABS)

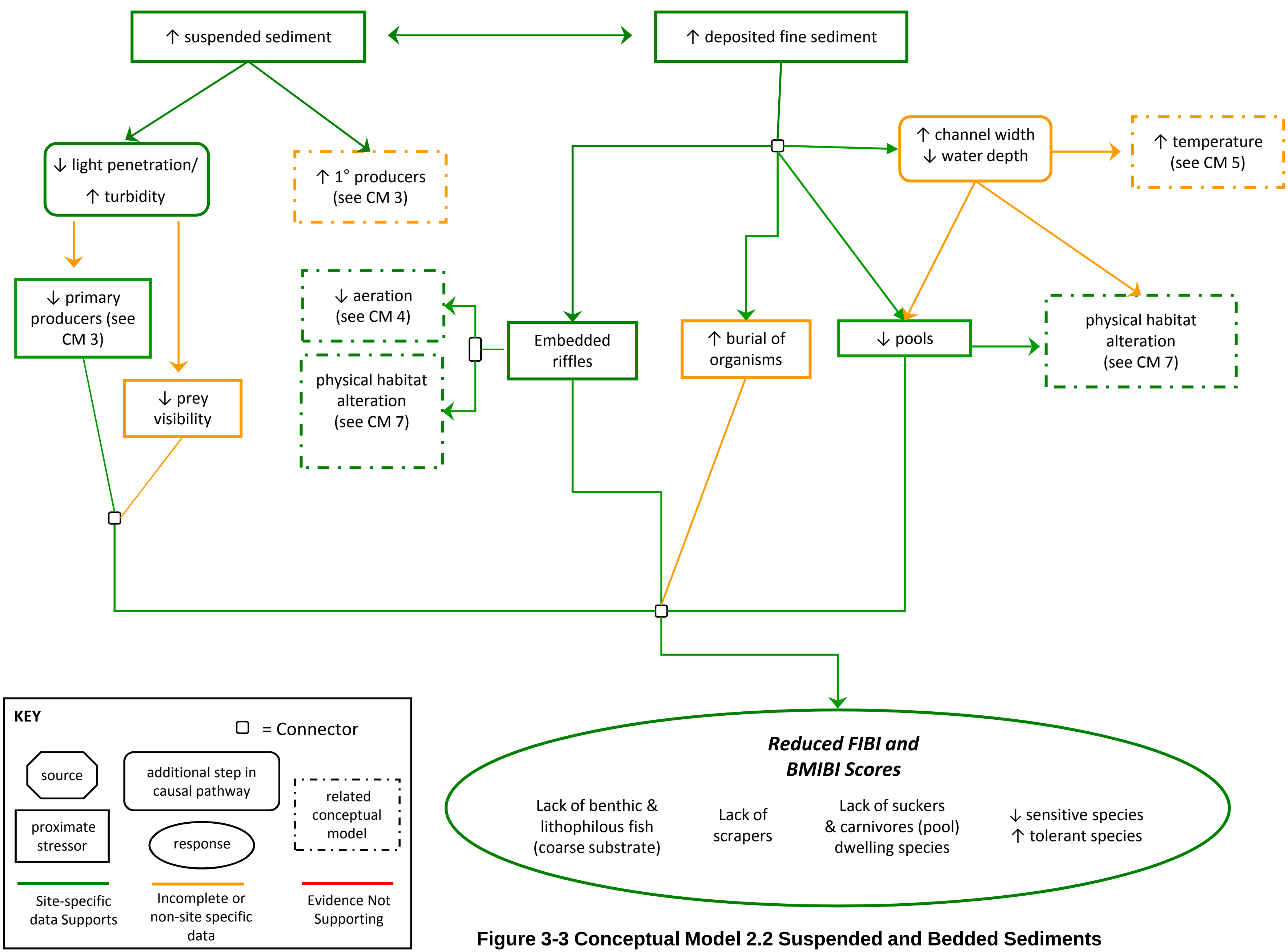


Figure 3-3 Conceptual Model 2.2 Suspended and Bedded Sediments

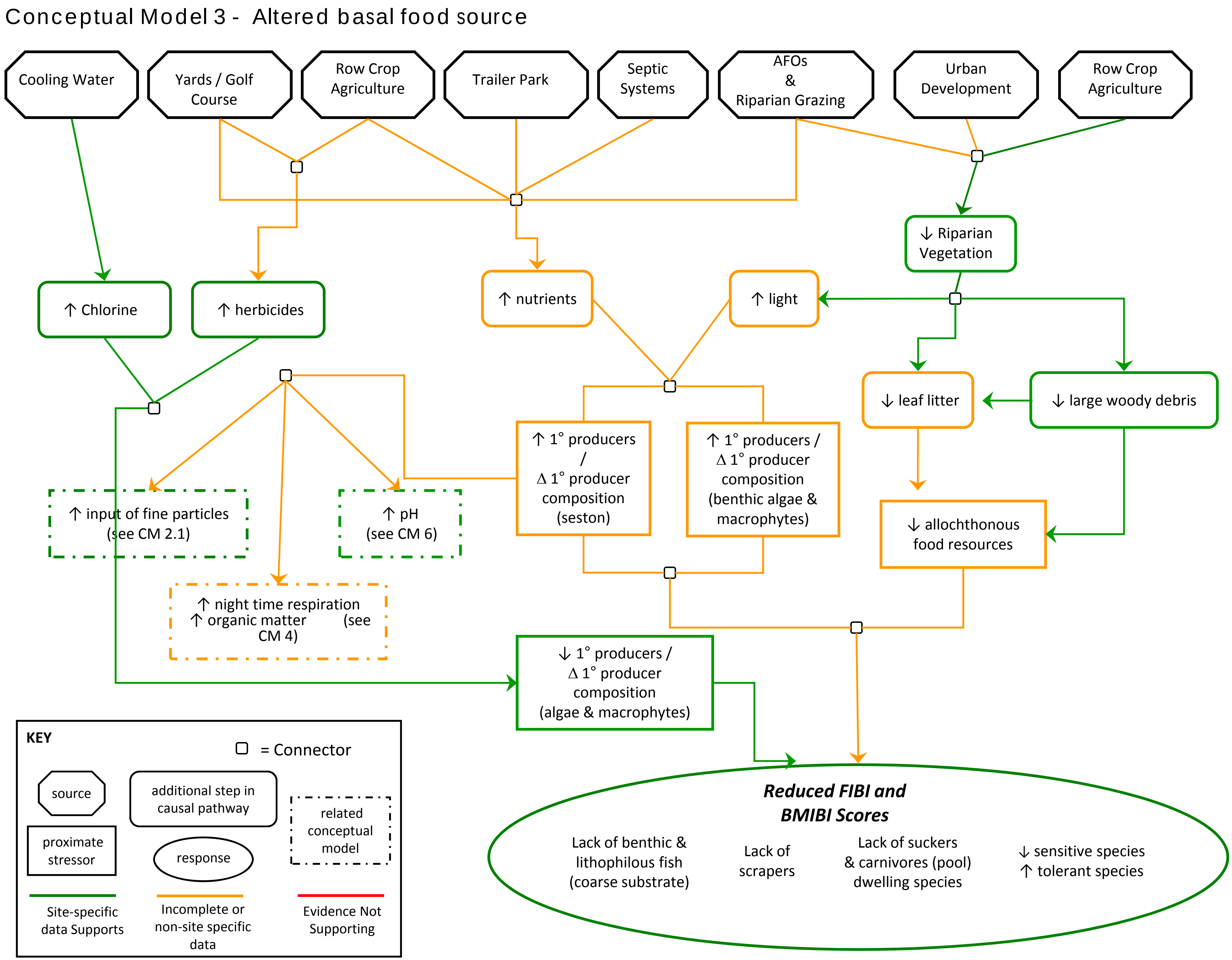


Figure 3-4 Conceptual Model 3 Altered Basal Food Source

Conceptual Model 4 - Decreased dissolved oxygen

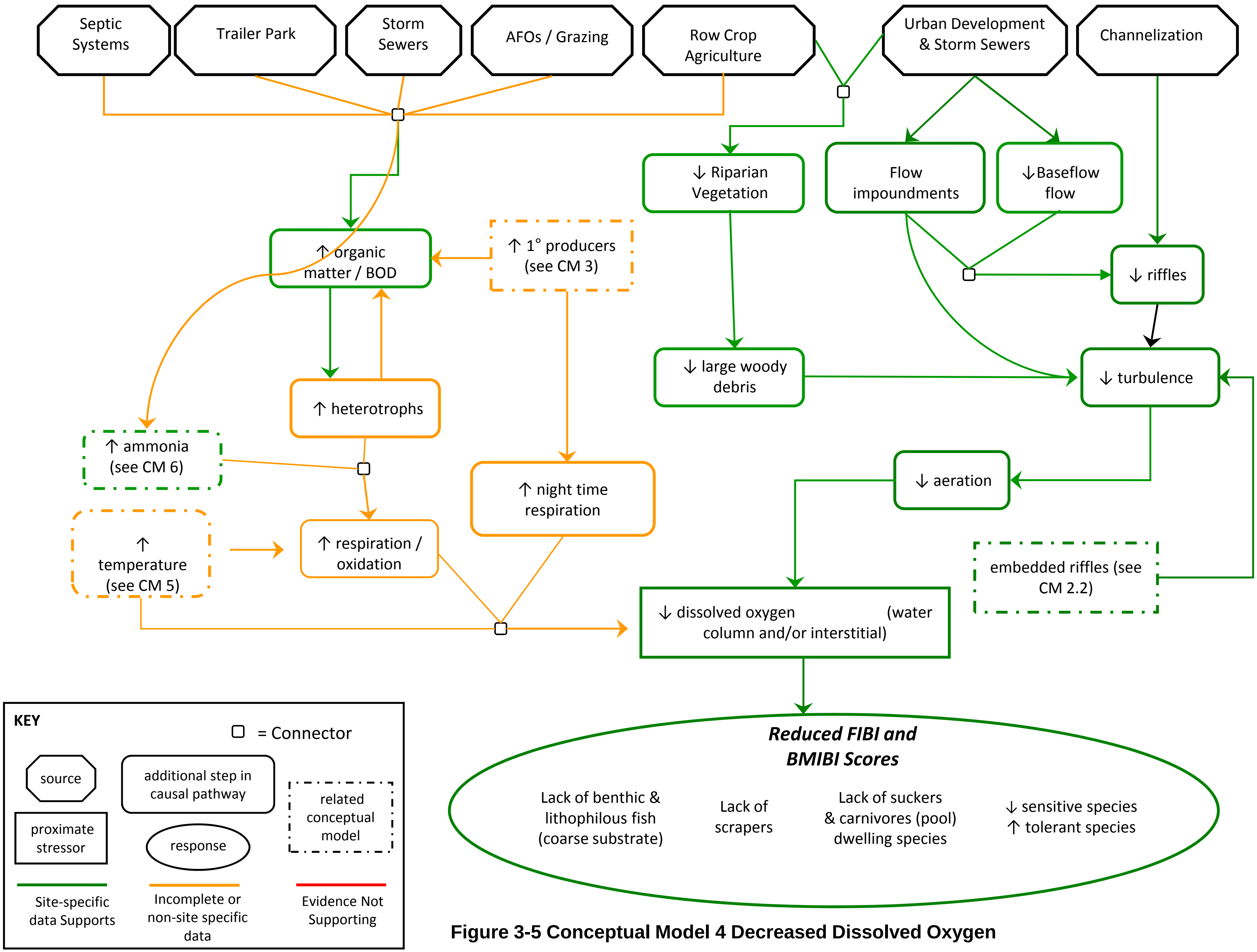


Figure 3-5 Conceptual Model 4 Decreased Dissolved Oxygen

Conceptual Model 5 - Altered temperature regime

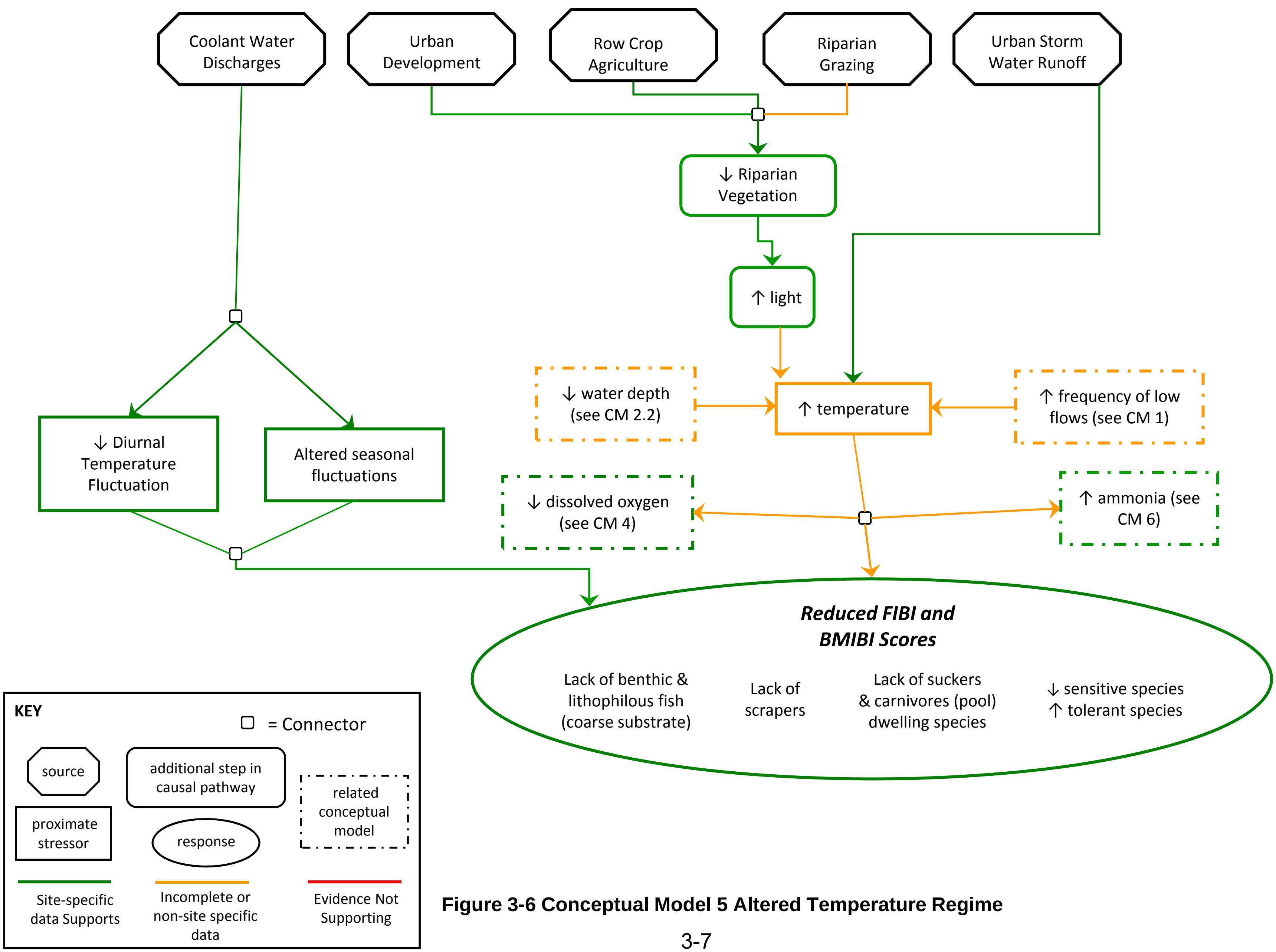


Figure 3-6 Conceptual Model 5 Altered Temperature Regime

Conceptual Model 6 - Elevated Ammonia

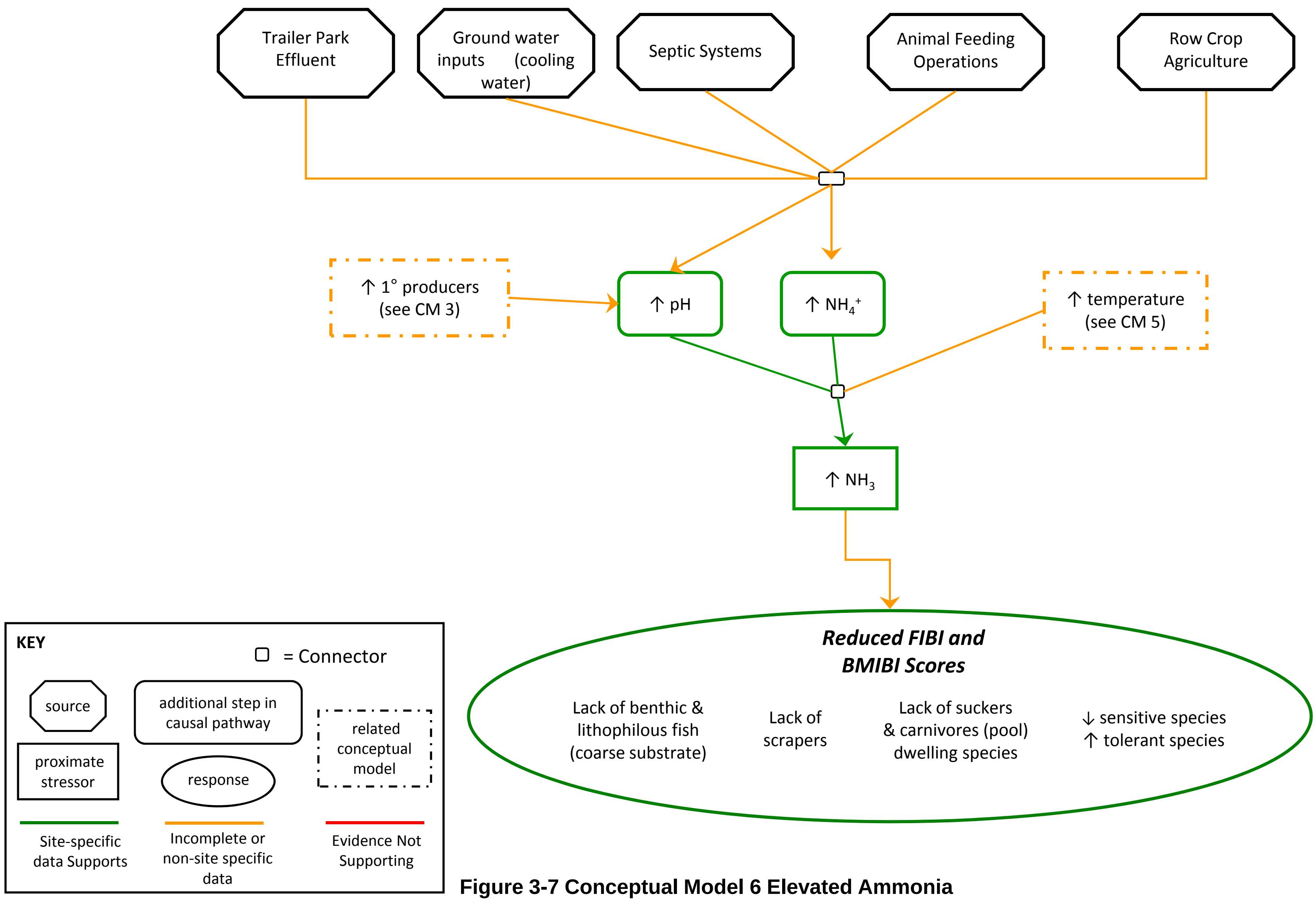


Figure 3-7 Conceptual Model 6 Elevated Ammonia

Conceptual Model 7 - Physical Habitat Alteration

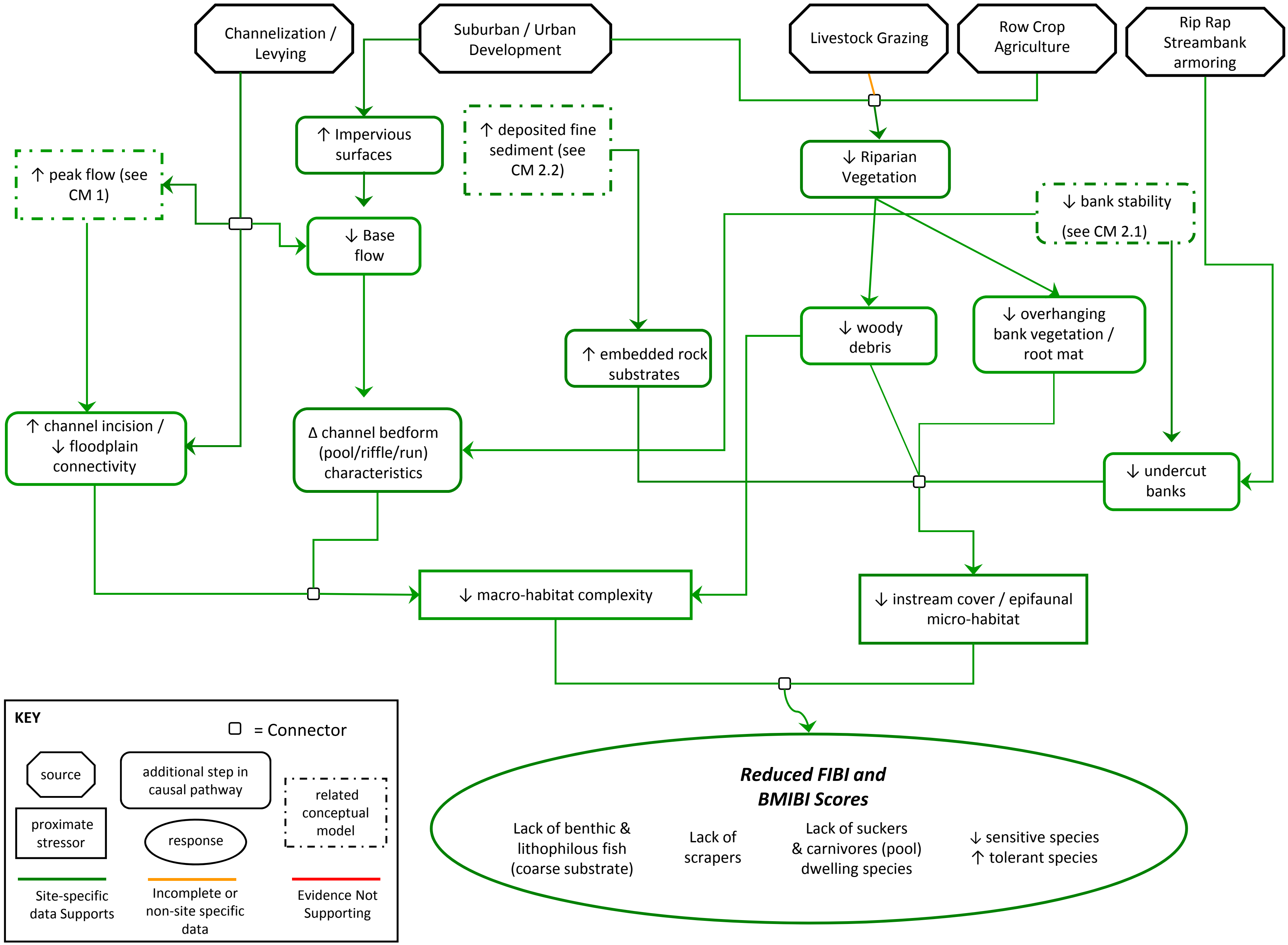


Figure 3-8 Conceptual Model 7 Physical Habitat Alteration

Conceptual Model 8 - Aquatic Life Depletion and Isolation

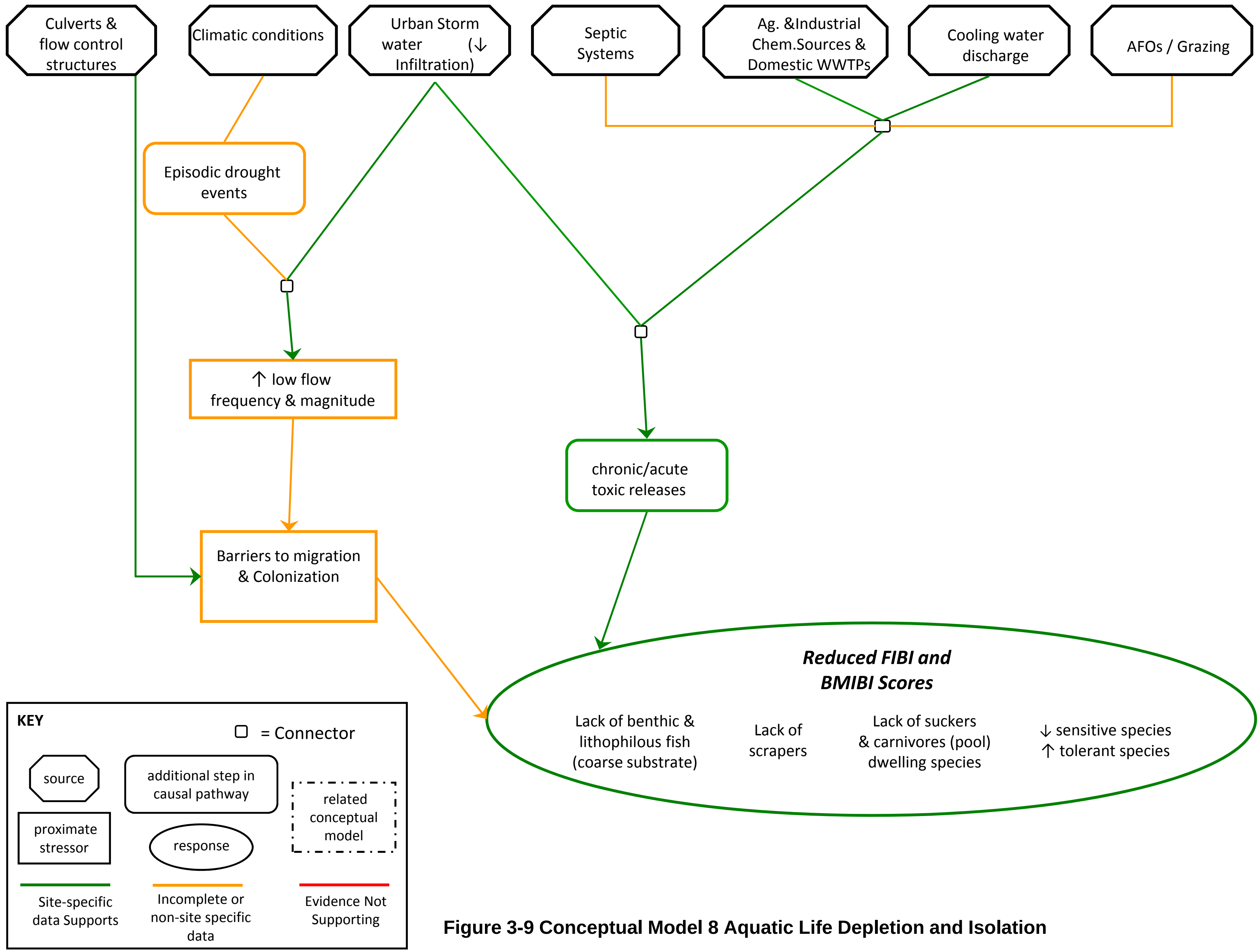


Figure 3-9 Conceptual Model 8 Aquatic Life Depletion and Isolation

Fourth Appendix UNI Study

Dry Run Creek Ecotoxicological Evaluation

Final Report Submitted to the Iowa Department of Natural Resources
In Fulfillment of IDNR Contract No. 07-04HA-07

By:

Kurt W. Pontasch, Ph.D.
Department of Biology
University of Northern Iowa

INTRODUCTION

Dry Run Creek is a small first-third order stream located within the city limits of Cedar Falls, Iowa. Residential and business areas constitute most downstream portions of the drainage, but some upstream reaches flow through agricultural areas. The stream has three main branches, and the reach below their confluence has been channelized. Most stream reaches were biologically assessed by the Iowa Department of Natural Resources (IDNR) in October, 2005. Results from that rapid bioassessment suggested that the middle branch has fewer sensitive benthic macroinvertebrates relative to other areas of the drainage. Benthic macroinvertebrate populations in the middle branch have been depauperate since at least 1989 (personal observation).

The objective of this research was to quantify macroinvertebrate population densities, and periphyton samples were taken to quantify chlorophyll *a* and biomass. In addition, toxicity screenings of selected effluents were undertaken to determine if they are having an impact on the stream.

METHODS

Funding for this contract provided for 1) monthly (May 2006 through April 2007) macroinvertebrate density quantification at four sites; 2) monthly periphyton sampling for Chlorophyll *a* and biomass quantification at four sites; 3) weekly temperature (max./min.) readings at four sites; 4) monthly toxicity screening of a cooling water effluent with *Daphnia magna*; 5) additional monthly toxicity screenings with *D. magna* of other effluents identified by the IDNR; 6) toxicity screenings with *D. magna* of storm water runoff from effluent pipes identified by the IDNR; and 7) a 30 day colonization of benthic macroinvertebrate and periphyton communities in the Cedar River for transplantation to each site for a 7 day *in situ* test during September, 2006.

MONTHLY SAMPLING ON DRY RUN CREEK

Study Area

Four riffle sites were chosen for research (Figure 1). The first two sites were located upstream and downstream of a cooling water effluent pipe. They were designated as UHU (University/Hudson Upstream) and UHD (University/Hudson Downstream). The third and fourth sites further downstream were designated as Roth (Roth Biological Preserve) and CFU (Cedar Falls Utilities). Sites UHU, UHD, and Roth are all located on the middle branch of Dry Run Creek while CFU is below the confluence of the three main branches and near the Cedar River. The UHU site is located at the northwest corner of University Avenue and Hudson Road, behind Erickson Automotive. The riffle is composed of mostly medium sized cobbles and some sand. The south side of the bank consists of large, broken pieces of cement rip-rap for bank stablility. The south bank also has many pieces of scrap iron on the bank as well as in the water. Vegetation consists of trees and shrubs. The north bank is held in place by trees and grass. Overall, the banks appear stable. The site has a canopy cover of 80-85%. During the duration of the study, UHU had a continuous flow of water but was frozen from early January to early February.

The second site, UHD, is also located at the northwest corner of University Avenue and Hudson Road, behind Erickson Automotive downstream from the cooling water effluent. The riffle is composed of cobbles larger than 15 centimeters and pebbles (1-4 cm.) ~25% embedded in sand. The north and south banks and percent canopy cover are the same as described above for UHU. However, this site did not freeze in January, so samples could be collected on all twelve sample dates.

The Roth riffle is located north of the Roth Biological Preserve and is downstream from the first two sites. The riffle is composed of medium (6-13 cm) and large (13-25 cm) cobbles, ~25% embedded in sand pebbles. Both the north and south banks are dirt with vegetation consisting of trees and shrubs, and appear to be moderately stable. The canopy cover for the site is 60-70%. Water flowed continually at this site so samples were collected on all twelve sample sates.

The CFU riffle is located behind Cedar Falls Utilities just upstream from where Dry Run Creek enters the Cedar River. The site was identified as DRC1 during the rapid bioassessment by the IDNR. The riffle is composed mostly of larger cobbles (10-15 cm.) ~25% embedded in sand and pebbles. The west bank of the site consists of a large sand bar with a bank reinforced with cement rip-rap behind it. The east bank has a bike trail that runs parallel to it and is also reinforced with cement rip-rap. Stream bank vegetation consists of a few small trees, grass, and weeds. There is no canopy cover at this site. Sampling was not possible at this site for the months of May, 2006, and January, February, March, and April, 2007 because it was either flooded or frozen.

Macroinvertebrates

To reduce community composition variability caused by natural substrate differences among sites, macroinvertebrate communities were colonized in rock-filled plastic containers (10.6 X 10.6 X 8.3 cm) with six circular holes (12 mm dia) in each side. River rock (4-6 cm dia), purchased at a sand and gravel pit, was used to fill the plastic containers. Eight artificial substrates were secured monthly to each of two wooden frames that were anchored to the stream bottom at each site with iron rods and concrete blocks.Substrates were introduced into Dry Run Creek at three of the sites (UHU, UHD, and Roth) on 5-8-2006 and one site (CFU) on 6-7-2006. They were visited monthly thereafter for one year. CFU could only be collected through 1-9-2007 because of freezing and flooding.

Artificial substrates were allowed to colonize for 30 days. Previous studies have shown that a 30 day colonization period is sufficient to ensure that macroinvertebrate species equilibrium has been achieved (Pontasch, 1995). After colonization, substrates were removed by placing a dip net behind each substrate during removal from the frame. The contents of four randomly selected substrates and organisms captured in the dip net were then rinsed through a 500 micron sieve, and the sieve contents (minus the river rock) were preserved in four labeled jars containing 80% ethanol. All colonized substrates were removed at the end of each sampling trip and replaced with new substrates.

Organisms were sorted in the lab and identified to genus or the lowest practical taxonomic level. For example, Chironomidae (Insecta: Diptera) were identified to subfamily level.

Macroinvertebrate taxa were considered a "core" taxon and analyzed statistically if they contained a mean of four or more individuals at one site, on at least one sampling date, during the study. Remaining taxa were not statistically analyzed. The density of individuals in each "core" taxon were compared both between sites on each sampling date (see Figures 2-14). The data were analyzed by a one-way analysis of variance (ANOVA) followed, when significant ($p \leq 0.05$), by Duncan's Multiple Range Test for the separation of means.

Temperature (°C), dissolved oxygen (mg/L), salinity (ppt), pH, conductivity (mS/cm), hardness (mg/L $CaCO_3$), and alkalinity (mg/L $CaCO_3$) were monitored at each site on each sampling date.

Periphyton

Periphyton was colonized on eight artificial substrates attached to the anchored macroinvertebrate substrate frames at each study site. The periphyton artificial substrates consisted of square, high-density, plastic container lids (10.8 X 10.8 cm) roughened with coarse sandpaper. After the 30 d colonization, all eight periphyton substrates were removed and placed in a cooler filled with source riffle water for transportation to the laboratory.

Upon arrival at the laboratory a sample was taken from five randomly selected substrates by scraping a delimited surface area with a bristle brush and filtering the scrapings onto Whatman GFC filter paper. Determination of chlorophyll *a* concentration was made with one half of the filter paper, and biomass (ash-free dry weight) was determined from the other half (APHA et al. 1989). From this the autotrophic index (AI) can be calculated:

$$AI = \text{Biomass } (mg/m^2) \,/\, \text{Chlorophyll } a \ (mg/m^2)$$

The Autotrophic Index (AI) is a unit-less measure used to determine the trophic status of periphytic communities(i.e. heterotrophs versus autotrophs). Normal values range from 50-200 and values above 200 indicate possible organic enrichment (APHA *et al.*, 1989). Chlorophyll *a*, biomass and the AI values from each site were analyzed by a one-way analysis of variance (ANOVA) followed, when significant ($p \leq 0.05$), by Duncan's Multiple Range Test for the separation of means.

EFFLUENT TOXICITY TESTS

The main cooling water effluent of focus was located at the corner of University Avenue and Hudson Road behind Erickson Automotive and is thought to be cooling water for the UNI power plant. This site was identified as DRC6 by the IDNR, but this discharge point did not appear to be in use for most of the study. However, the small volume discharged was sampled monthly. Other effluents were tested that were suggested by the IDNR along with some that were not. Not all effluent pipes had flowing water on all collection dates. Toxicity screening was also done during selected storm/flood events. Effluents from storm water runoff were collected from selected points of discharge. Overall, 6-9 effluents were tested for toxicity with *Daphnia magna* each month, and a total of 18 effluents were evaluated.

For each test, effluent grab samples were taken in plastic cubitainers and transported back to the laboratory. Effluents were allowed to reach room temperature before toxicity tests were run. Ten *D. magna* neonates were then exposed for 96 hrs. to 0 and 100% effluent in a temperature controlled room at 20°C. A 12 hr. photoperiod was provided by two, 120 cm. Durotest Vita-lites. Any screening test which resulted in mortalities >10% in the 100% treatment were then followed by a definitive test in which a series of duplicate concentrations (0, 6.25, 12.5, 25, 50 and 100% effluent) were used to determine an LC50 using Spearman-Karber analysis. Effluent temperature (°C), dissolved oxygen (mg/L), salinity (ppt), pH, conductivity (mS/cm), hardness (mg/L $CaCO_3$), and alkalinity (mg/L $CaCO_3$) were all recorded before testing.

IN SITU TESTS

During August and September, 2006, *in situ* tests with macroinvertebrates and periphyton colonized in the Cedar River, Cedar Falls were attempted.

Macroinvertebrate communities were developed in rock-filled plastic containers (10.6 X 10.6 X 8.3 cm) with six circular holes (12 mm dia) in each side. River rock (7-9 cm dia) purchased at a local sand and gravel pit, was used to fill the plastic containers. Artificial substrates (42) were secured to 6 wooden frames that were anchored to the Cedar River bottom with iron rods and concrete blocks. The Cedar River riffle used for colonization is on the west side of the 1st Street bridge in Cedar Falls, Iowa. The artificial substrates were allowed to colonize for 30 days. Colonized substrates were then removed by placing a dip net behind each substrate during the removal from the frame. The contents of 5 randomly chosen substrates were placed in separately labeled jars containing 80% ethyl alcohol for preservation. This provided an estimate of the macroinvertebrate species and their densities that were transferred. Another 25 colonized substrates were randomly placed in coolers filled with river water and transported to the *in situ* test sites.

The *in situ* sites were the four sites on Dry Run Creek plus a reference site in the Cedar River riffle. At each of the sites, 5 colonized substrates were placed in a wooden frame identical to those used for colonization with the exception that it was enclosed in a 76 X 97 X 18 cm (H,W,D) frame covered by a screen (mesh size ~ 1.0 mm) that prevented emigration or immigration of most macroinvertebrates. After 7 days, the artificial substrates at each *in situ* site were sampled and processed as described above for the monthly testing. Temperature (°C), dissolved oxygen (mg/L), salinity (ppt), pH, conductivity (mS/cm), hardness (mg/L $CaCO_3$), and alkalinity (mg/L $CaCO_3$) were monitored at each site during transfer and sampling.

Periphyton was colonized on 42 artificial substrates affixed to the anchored frames in the Cedar River. The periphyton artificial substrates consisted of square, high-density, plastic container lids (10.8 X 10.8 cm) previously roughened with coarse sandpaper. After the 30 day colonization, five periphyton substrates were sampled immediately to provide a reference for how much was colonized. Then 35 of the remaining substrates were transferred with the macroinvertebrate substrates and sampled after 7 days. Periphyton analysis was conducted, as outlined above under monthly testing, on 5 randomly chosen substrates of the seven at each site.

Macroinvertebrate densities, chlorophyll *a*, periphyton biomass, and Autotrophic Index values were compared among the sites/treatments using one-way ANOVAs followed, when significant ($p \leq 0.05$), by Duncan's Multiple Range test for the separation of means

RESULTS AND DISCUSSION

PHYSICAL/CHEMICAL CHARACTERISTICS

Physical and chemical data from each site during both the monthly sampling on Dry Run Creek and, during *in situ* testing, from the Cedar River are reported in Table 1. Overall, the water chemistry was similar among the Dry Run Creek sites, and they were similar to the Cedar River on the dates it was sampled. In addition, they appear normal for streams in this region. Unfortunately, the current velocity meter had to be sent for repairs which took 6 months so discharge data are not available from June through October, 2006. However, it is clear that discharge at Roth and CFU was considerable higher than at the two upstream sites (UHU and UHD). The weekly max/min temperature readings (Table 2) are also similar among the sites, but it is interesting to note the diel temperature fluctuations at Roth are less than those at the other sites. This is probably due to the "tall grass prairie" effluent which discharges large quantities of cooling/heating water upstream from Roth. A lack of diel temperature fluctuations has been shown to decrease species richness below low release dams.

MONTHLY SAMPLING ON DRY RUN CREEK

Macroinvertebrates

Insects were the most species rich class of macroinvertebrates found with 29 taxa identified over the course of the study (Appendix A). The 11 insect "core" taxa identified were all insects from the orders Ephemeroptera, Trichoptera, Diptera, Plecoptera, and Odonata. Other groups were collected in numbers too low to be included in the statistical analyses, but their numbers are listed with core taxa densities in Appendix B.

Mayflies (Ephemeroptera) included three "core" taxa, *Baetis* sp. (Baetidae), *Heptagenia* sp. (Heptageniidae), and *Stenacron* sp. (Heptageniidae). All three taxa exhibited variable densities during the study (Figs. 2-4). Mayflies are generally considered sensitive organisms which only inhabit relatively clean waters.

Baetis sp. were found in all months with the exceptions of January through March, 2007. In addition they were found at all sites but on different dates (Fig. 2). There were significantly ($p \leq 0.05$) higher numbers at CFU from June through October, 2006 which is probably due to that site's proximity to the Cedar River. During April, 2007 there were significantly ($p \leq 0.05$) more *Baeitis* sp. at Roth relative to the two upstream sites (Fig. 2). The highest densities observed (~40/artificial substrate) are on the low end of what is considered a normal *Baetis* sp. colonization of the artificial substrates used in this study (e.g., see Fig. 18).

Heptagenia sp. were found only during the months of May through July, 2006, and only at UHU, UHD, and Roth. Although the numbers are low, UHU and UHD had significantly ($p \leq 0.05$) higher densities than Roth during May and June, 2006 (Fig. 3).

Stenacron sp. were found on all dates except for May, 2006 and at all sites except for CFU (Fig. 4). There were significant differences ($p \leq 0.05$) in numbers for July through October and December, 2006, and for January, 2007 (Fig. 4). As was the case with *Heptagenia* sp. the numbers are relatively low, but UHU and UHD had significantly ($p \leq 0.05$) higher densities than Roth.

Three other mayflies were found during the study, but with numbers too low for statistical analysis were *Caenis* sp. (Caenidae), *Leptophlebia* sp. (Leptophlebiidae), and *Isonychia* sp. (Isonychiidae) (Appendix B). *Leptophlebia* sp. was found at UHU in September 2006 and at both UHU and UHD during October, 2006. *Caenis* sp. was found at UHU and UHD at multiple times throughout the year and at Roth during only February and March, 2007. *Isonychia* sp. was found only once during October, 2006 at site UHD. Overall, it appears that UHU and UHD allow for a greater mayfly species richness than Roth.

The order Plecoptera contained only one "core" taxon. *Claassenia* sp. (Perlidae) was collected in May, June, and November, 2006 as well as March and April, 2007 (Fig. 5). They were found at UHU, UHD, and Roth but not at CFU. Numbers were generally low but were highest, and near normal for this predator, at UHU and UHD in May, 2006 when both sites had significantly ($p \leq 0.05$) higher densities than Roth. On other sampling dates when *Claassenia* sp. was present, the numbers are too low to make meaningful comparisons. (Fig. 5). Plecoptera are also considered to be sensitive macroinvertebrates which generally only inhabit clean, well-oxygenated waters. The only other Plecoptera taxon found during this study was a single *Taeniopteryx* sp. (Taeniopterygidae) at UHD during January, 2007 (Appendix B). Once again, it appears that the two upstream sites, and especially UHD, may allow for a higher taxonomic richness of sensitive organisms.

The order Trichoptera contained only one "core" taxon, *Hydropsyche* sp. (Hydropsychidae). Although Trichoptera are considered, along with Ephemeroptera and Plecoptera, to be "clean water" organisms, the genus *Hydropsyche* is considered one of the least sensitive groups of Trichoptera (e.g., Pontasch and Cairns, 1991). They are often among the most abundant insects in streams with high organic enrichment and are also relatively insensitive to some heavy metals. *Hydropsyche* sp. were found at all sites and dates that were sampled, except for UHU in December, 2006 (Fig. 6). Colonization densities were higher than those of most other taxa from May through September, 2006 with UHD having the highest number during June, 2006 at over 140 individuals per artificial substrate. However, these densities are actually quite low for this taxon which selectively colonizes the artificial substrates used in this study (e.g., see Fig. 22). There were significant ($p \leq 0.05$) differences in numbers from May through September, November and December, 2006, and February through April, 2007 (Fig. 6) with Roth having lower numbers than at least one other site on most sampling dates. The only other Trichoptera found were one *Brachycentrus* sp. (Brachycentridae) at Roth and one *Ochrotrichia* sp. (Hydroptilidae) at CFU both in August, 2006 (Appendix B).

Diptera was the most taxa rich order of insects collected in this study with 5 "core" taxa. Three of the core taxa belonged to the family Chironomidae, one to Simuliidae, and one to Ceratopogonidae.

Members of the Chironomidae subfamily Tanypodinae are not readily distinguishable with a dissecting microscope and, therefore, were considered one "core" taxon. Tanypodinae were found at all sites during some point of the study (Fig. 7). Their numbers were highest and near normal (at some sites) from November, 2006 through April, 2007 at the sites that were collected. There were significant ($p \leq 0.05$) differences in numbers from September, 2006 through January, 2007 with Roth, once again, containing significantly ($p \leq 0.05$) fewer organisms than the two upstream sites. However, in March, 2007 Roth had significantly ($p \leq 0.05$) more organisms than UHD but not UHU (Fig. 7).

Genera of the subfamily Orthocladiinae are also difficult to differentiate with a dissecting microscope and were considered one "core" taxon. Orthocladiinae were found at all sites at some point during the study (Fig. 8). Their numbers elevated along with Tanypodinae and were near normal (at some sites) from November, 2006 through April, 2007. Also similar to the Tanypodinae there were significant ($p \leq 0.05$) differences in numbers from May, 2006 through January, 2007 when Roth contained significantly ($p \leq 0.05$) fewer organisms than the upstream sites. However, in March and April, 2007 Roth was significantly ($p \leq 0.05$) higher than UHD but not UHU (Fig. 8).

As above, all genera of the subfamily Chironominae were considered one "core" taxon. Chironominae were generally lower in number compared to the other two subfamilies of Chironomidae and, in most cases, did not reach "normal" colonization densities. The highest numbers found were at site UHU during May, 2006 with over 10 individuals per artificial substrate (Fig. 9). As with the *Hydropsyche* spp. noted above, Chironominae densities generally increase greatly in organically enriched waters. The fact that these two taxa exhibited lower than "normal" colonization suggests that there is little, if any, organic enrichment in Dry Run Creek. The only significant ($p \leq 0.05$) difference in numbers occurred in September, 2006 with UHU having higher densities than all other sites (Fig. 9).

Another "core" dipteran taxon was *Simulium* sp. (Simuliidae). *Simulium* sp. were found at all sites during the study (Fig. 10). Numbers were highest from May through July, 2006 especially at the two downstream sites (Roth and CFU). A sharp drop in numbers for August, 2006 may have been due to adult emergence. Thereafter, numbers were generally higher at the upstream sites (especially UHU). There were significant ($p \leq 0.05$) differences in numbers for June and July, 2006 when the downstream sites had higher numbers, and October, 2006 through April, 2007 when the upstream sites were higher (Fig. 10).

The last "core" dipteran taxa was *Probezzia* sp. (Ceratopogonidae). *Probezzia* sp. only appeared during May, 2006 and March and April, 2007, and only samples from UHD contained individuals (Fig. 11) Therefore, comparisons among sites is not appropriate. However, it is interesting to note that, once again, the upstream sites, in this case UHD, appear able to support a greater taxa richness.

Three other dipteran genera were collected but not considered "core" taxa. *Hemerodromia* sp. (Empididae) and *Tipula* sp. (Tipulidae) were collected at all sites during some point of the study (Appendix B). *Tipula* sp. were usually large, and the samples generally contained one or two individuals per artificial substrate. A single *Hexatoma* sp. (Tipulidae) was collected at UHU during May, 2006.

The order Odonata contained only one "core" taxon, *Calopteryx* sp. (Calopterygidae). It was found only at UHU during July, 2006 (Fig. 12). Other Odonata that were not considered "core" taxa were *Argia* sp. (Coenagrionidae) and Aeshnidae (Appendix B). *Argia* sp. were found throughout the study at different sites and dates. Aeshnidae was found only once at UHU during May 2006 with only one individual which was too small and damaged to key to genus.

The order Coleoptera contained several taxa but numbers were too low for statistical analysis. *Stenelmis* sp. (Elmidae), *Ordobrevia* sp. (Elmidae), and *Dubiraphia* sp. (Elmidae) were found throughout the study in low numbers at different sites and on different dates (Appendix B). *Lara* sp. (Elmidae) and *Tropisternus* sp. (Hydrophilidae) were found at UHU during May, 2006. Similarly, *Agabinus* sp. (Dytiscidae) was found at UHU and UHD during May, 2006 and *Ilybius* sp. (Dytiscidae) was found at UHD during June, 2006. Once again, the two upstream sites appear to support a greater taxonomic richness.

Bivalve molluscs were collected from all sites but only broken or partial shells were recovered so they could not be identified. In addition, the numbers were too low for statistical analysis. The same was true for the few oligochaetes (Annelida) that were found. Finally, two amphipod (Crustacea) genera, *Gammarus* sp. and *Hyalella* sp., were collected at all sites during some point in the study, but neither were "core" taxa (Appendix B).

Total macroinvertebrate densities were significantly ($p \leq 0.05$) different among the four sites during the entire study except for February, 2007 (Fig. 13). Although the two upstream sites were significantly ($p \leq 0.05$) higher than Roth for five of the months, no site had the highest total densities for the entire study. However, as noted above, the two upstream sites, UHU and UHD, had a higher taxonomic richness during nearly every month of the study (Fig. 14).

Periphyton

On most dates periphyton appeared as a thin brown biofilm at all sites. All sites on Dry Run Creek had relatively the same values (~5000 mg/m^2) for biomass on each sampling date. However, there were significant ($p \leq 0.05$) differences in biomass for the months of May, June, November, and December, 2006 (Fig. 15). These biomass values can be considered normal and not indicative of an organically enriched stream. For example, McCloud Run, an enriched stream in Cedar Rapids, Iowa, had biomass values that were consistently more than an order of magnitude higher than Dry Run Creek (see IDNR contract no. 03-04HA-03 final report). Although a high biomass value was found at UHD in January, 2007 (exceeding 30,000 mg/m^2), this value was influenced greatly by one sample that had a value of 140,500 mg/m^2..

Chlorophyll *a* values fluctuated throughout the study with different sites having the highest chlorophyll *a* values on different dates (Fig. 16). Chlorophyll *a* levels were significantly ($p \leq 0.05$) different on most dates except for November and December, 2006 and January and March, 2007 (Fig. 16). The Roth site was significantly ($p \leq 0.05$) higher than the two upstream sites in May, 2006 and April, 2007, but exhibited extremely low values during the summer months. This could have been due to its relatively thicker canopy cover, the cooling water effluent (tall grass prairie) located between the two upstream sites and Roth, or some other factor. When CFU could be sampled it generally had the highest chlorophyll *a* levels probably because there is no canopy cover at that site. The highest values were reached at all sites in December, 2006. In comparison to other streams the chlorophyll *a* concentrations in Dry Run Creek are low to normal. An oligotrophic stream in Idaho had values similar to those found in Dry Run Creek (Pontasch and Brusven, 1987). While McCloud Run in Cedar Rapids had chlorophyll *a* levels (at McLoud Place) that were often an order of magnitude or more higher.

Autotrophic Index values fluctuated from site to site as well as from month to month throughout the study (Figure 17). The APHA *et al.*, (1989) state that normal values range from 50-200 and values above 200 indicate possible organic enrichment. The AI values in this study often exceeded 200. For example, the August sample from UHU exceeded 8000 and the February sample from UHD exceeded 7800. However, these high values were due to extremely low chlorophyll *a* concentrations, not high biomass (see Figures 15 and 16). Overall, it appears that there is little organic enrichment in Dry Run Creek, but chlorophyll *a* concentrations are exceptionally low.

EFFLUENT TOXICITY TESTS

The cooling water effluent from University/Hudson (identified by the IDNR as DRC6) was collected every month except for June, 2006 when there was no flow of water. Toxicity tests with the cooling water found that 100% effluent was not toxic to *Daphnia magna* at any point during the study so no definitive tests were run.

A total of 17 other effluents (Table 3) were also evaluated at some point during the study with six to nine effluents sampled each month (Table 4). Those toxicity screenings did result in some effluents exhibiting toxicity. The "UNI Towers" effluent was toxic to *D. magna* during May, June, August, September, and October, 2006 (Table 5). Spearman-Karber LC50s for 'UNI Towers" ranged from 4.4 to 61.9% effluent. The lower value being a serious cause for concern. The "University Bridge E." effluent was toxic during May and September, 2006 (Table 5). Other effluents found to be toxic were "University Bridge W." in May, 2006, "Panther Lane" in December, 2006, and "Tall Grass Prairie" in April, 2007 (Table 5). For each effluent found to be toxic additional tests were conducted in an attempt to determine the source of toxicity. One of the first steps in a Toxicity Identification Procedure (TIE) is to aerate the effluent for 24 hours, and then test for toxicity again. Every toxic effluent found in this study was nontoxic after aeration. This coupled, in most cases, with a strong odor, suggests that chlorine is the likely source of toxicity in these effluents. The "Tall Grass Prairie" effluent is apparently not listed by the IDNR, but is located between the two upstream sites and Roth. This pipe is large in size with a steel door covering it. Water was flowing from this pipe each time it was visited but at different levels. The low LC50 (3.75% effluent) at this site is a serious cause for concern. A short release at such a high level of toxicity and volume would severely impact downstream areas (i.e. Roth) for long periods even if it only occurred once or twice annually.

Toxicity screening was also done during selected storm events (Table 4). Although this was hard to accomplish because water levels in Dry Run Creek rise rapidly making it unsafe to wade in, two storms were tested during the year. The first was collected on July 11, 2006 and the second on April 25, 2007 from selected storm water effluents. No toxicity from stormwater runoff was found either time.

IN SITU TESTS

Macroinvertebrates

Only three sites (UHU, UHD and Roth) could be sampled at the end of the *in situ* test in Dry Run Creek. The transferred substrates at CFU and the reference riffle in the Cedar River were damaged when high water and associated debris caused large holes in the mesh screen that enclosed the artificial substrates. Because those holes allowed for immigration and emigration of macroinvertebrates they could no longer be used. Therefore, instead of using the Cedar River samples after transfer (CRA) as a reference, the Cedar River samples before transfer (CRB) were used. This gives an indication of the taxa and their densities which were transferred to Dry Run Creek, but does not control for any losses due to the transfer. However, those losses should have been minimal (see Pontasch and Cairns, 1991).

Sixteen insect taxa were identified to subfamily or genus and 11 were considered "core" taxa for statistical analysis. The "core" taxa were in the orders Ephemeroptera, Diptera, Coleoptera, and Trichoptera. Lepidoptera, Megaloptera, Odonata, and Plecoptera numbers were too low for statistical analysis but are listed with the core taxa in Table 6.

Mayflies (Ephemeroptera) included four "core" taxa; *Baetis* sp. (Baetidae), *Isonychia* sp. (Isonychiidae), *Caenis* sp. (Caenidae), and *Stenonema* sp. (Heptageniidae). *Baetis* sp. numbers were high prior to transfer with almost 120 per artificial substrate in the CRB samples. After 7 days in Dry Run Creek numbers dropped significantly ($p \leq 0.05$) to below 5 per artificial substrate at each of the sites (Fig 18). *Isonychia* sp. responded similarly with numbers significantly ($p \leq 0.05$) higher in the samples prior to transfer (more than 60 per artificial substrate) than after 7 days at the sites on Dry Run Creek (less than 10 per artificial substrate; Fig. 19). Similar significant ($p \leq 0.05$) drops in numbers occurred for *Stenonema* sp. and *Caenis* sp. (Figs 20 and 21). *Heptagenia* sp. (Heptageniidae) was the only other mayfly found in the CRB samples, but did not have numbers high enough to statistically analyze (Table 6). Ephemeroptera are considered to be sensitive taxa and their drastic reduction in numbers following transfer to sites on Dry Run Creek is a cause for concern. However, given the loss of the CRA samples, it is possible, though not likely, that the reduction was in some way related to the transfer.

Trichoptera were represented by one "core" taxa, *Hydropsyche* sp. (Hydropsychidae) which was the only trichopteran found during the *in situ* test. Number per artificial substrate were nearly 1400 in the CRB sammples, and after 7 days at the sites on Dry Run Creek, the numbers showed little difference from the CRB samples (Fig. 22). Although Hydropsyche spp. are generally more tolerant than other Trichoptera (Pontasch and Cairns, 1991), the ability of these filter-feeders to survive so well within the screened substrate frames is surprising because they are not maintained well in artificial streams with limited filterable nutrients (Pontasch and Cairns, 1991).

Five of the "core" taxa Orthocladiinae (Chironomidae), Tanypodinae (Chironomidae), Chironominae (Chironomidae), *Simulium* sp. (Simuliidae), and *Hemerodromia* sp. (Empididae) were dipterans. Orthocladiinae numbers per artificial substrate prior to transfer were relatively low, but were significantly ($p \leq 0.05$) lower after 7 days at the three Dry Run Creek sites (Fig. 23). Tanypodinae and Chironominae also colonized the CRB substrates in relatively low numbers, but did not drop significantly ($p > 0.05$) after transfer to the Dry Run Creek sites (Figs. 24 and 25). *Simulium* sp. in the CRB samples numbered over 70, but they were not present in any of the samples after 7 days at the three sites on Dry Run Creek (Fig. 26). One could argue that the screened substrates provided little filterable material for these filter-feeders, but another filter-feeder, *Hydropsyche* sp. was maintained in high numbers (see above). *Hemerodromia* sp. colonized the CRB substrates in extremely low numbers, but increased in numbers after transfer to the Dry Run Creek sites (Fig. 27). This may have been due to variability among the colonized substrates prior to transfer or to eggs hatching following transfer. There were no significant ($P > 0.05$) differences in numbers among sites. No other Diptera were found in the samples. Overall, only two of the five dipteran "core" taxa were adversely affected by spending 7 days in

Dry Run Creek which is not surprising for these relatively tolerant taxa.

Coleoptera included one "core" taxa, *Ordobrevia* sp. (Elmidae). *Ordobrevia* sp. numbers per artificial substrate were at more than 20 prior to transfer from the Cedar River riffle. Numbers did not drop significantly ($p>0.05$) at UHU or UHD, but were significantly ($p\leq0.05$) lower at Roth (Fig. 28). Another Coleoptera than was found was *Dubiraphia* sp. (Elmidae) which was only found in one substrate from UHU (Table 6). The Elmidae are relatively tolerant of pollutants as long as dissolved oxygen levels are sufficient (e.g., Pontasch and Brusven 1988) so their presence after 7 days in Dry Run Creek is not surprising.

Plecoptera were found in the samples but at numbers too low for statistical analysis. *Claassenia* sp. (Perlidae) were found in the Cedar River riffle prior to transfer at densities just over two per artificial substrate (Table 6). No *Claassenia* sp. were found at any Dry Run Creek sites after the transfer.

Odonata were found in samples from the Cedar River riffle and Roth but numbers were too low to be analyzed. *Argia* sp. (Coenagrionidae) was the only genus found, and it was only found in one substrate from CRB and one from Roth (Table 6).

Petrophila sp. (Pyralidae) was the only lepidopteran found during the entire evaluation. None were found in the CRB samples, but they were present in low numbers at all three sites on Dry Run Creek suggesting they may have hatched from eggs (Table 6).

The Megaloptera were represented by *Cordalus* sp. (Corydalidae). One organism was found in a sample from Roth, but no other sites had any present (Table 6).

Total macroinvertebrates in the CRB samples were significantly ($p\leq0.05$) higher than at UHU and UHD 7 days after transfer (Fig. 29). However, there was no significant ($p>0.05$) difference between CRB and Roth because of the higher number of Hydropsyche sp. present at Roth relative to UHU and UHD.

Total taxa richness was similar among the sites because, in most cases, sensitive taxa which dropped in numbers at the Dry Run Creek sites were not completely extirpated during the 7 day *in situ* test. This suggests that if stressors in Dry Run Creek can be eliminated a relatively "normal" assemblage of macroinvertebrate taxa at appropriate densities can be expected to develop.

Periphyton

Periphyton sampling could be performed at all sites during the *in situ* test because the periphyton artificial substrates were not damaged by flooding. Samples were taken prior to transfer from the Cedar River riffle (CRB) to determine what was transferred and again after 7 days (CRA) to act as a reference for the Dry Run Creek sites.

Biomass in the CRB samples was 16,400 mg/m^2 per artificial substrate and increased significantly ($p\leq0.05$) in the CRA samples to 27,600 mg/m^2 per artificial substrate; the highest of all the sites tested. Although all sites on Dry Run Creek had some increase in biomass relative to CRB during the 7 day test, UHU and CFU were significantly ($p\leq0.05$) lower than CRA, but not CRB (Fig. 31). Conversely, UHD and Roth were similar to CRA but significantly ($p\leq0.05$) higher than CRB. The increase in biomass during the 7 day test may have been due to the flood event or simply to the increased colonization time. CFU would have been expected to be more similar to CRA given its proximity to the Cedar River, but was actually more similar to UHU; the farthest upstream site.

Chlorophyll *a* increased significantly ($p \leq 0.05$) from 73.96 mg/m^2 per artificial substrate in the CRB samples to 124.16 mg/m^2 per artificial substrate in the CRA samples. UHU, UHD, and Roth chlorophyll *a* concentrations were similar to CRB but significantly ($p \leq 0.05$) lower than CRA (Fig. 32). However, CFU chlorophyll *a* did increase during the 7 day test and was not significantly ($p \leq 0.05$) different from CRA. This would be expected given CFU's proximity to the Cedar River and its lack of canopy cover. It should be noted that chlorophyll *a* values at all Dry Run Creek sites during the *in situ* test were considerably higher than during most of the monthly sampling (cf. Fig. 16). This suggests that in the absence of intermittent stressors, such as chlorine releases, Dry Run Creek should be able to support a "normal" algal biomass.

Autotrophic Index values were similar and "normal" in the CRB, CRA, UHU and CFU samples. Although they increased significantly ($p \leq 0.05$) at UHD and Roth, they were still relatively low and do not suggest organic enrichment in Dry Run Creek (Fig. 33).

CONCLUSIONS AND RECOMMENDATIONS

The macroinvertebrate data indicate that Dry Run Creek does have some of the so called "EPT taxa" (Ephemeroptera, Plecoptera and Trichoptera) considered indicative of unpolluted, healthy streams. Although Baetidae, one of the most commonly collected ephemeropterans, are considered a relatively tolerant mayfly, their presence along with other less tolerant mayflies during much of the year suggests that Dry Run Creek has the potential to support normal mayfly populations if stressors are eliminated. Similarly, the order Plecoptera (stoneflies) was collected in low numbers at three (UHU, UHD, Roth) of the four sites during study, but Plecoptera were only found at Roth During April 2007. Trichoptera were collected at all sites and on most sampling dates in relatively large numbers. However, most Trichoptera collected belonged to the family Hydropsychidae, a filter-feeding taxon often found in higher numbers in areas of increased organic enrichment. However, the hydropsychid densities in Dry Run Creek are not high enough to indicate organic enrichment. Tolerant dipteran fauna were present, but not in numbers that would suggest organic enrichment. Overall, the macroinvertebrate data suggest that intermittent stressors keep what could be a "normal" macroinvertebrate community in terms of species richness and densities from becoming established. This is especially true at Roth as compared to UHU and UHD.

Periphyton biomass, chlorophyll *a,* and Autotrophic Index values do not suggest major organic enrichment in Dry Run Creek. However, the low chlorophyll *a* concentrations during much of the year suggest that something is inhibiting algal production. Although canopy cover may be a factor at the three upstream sites, low levels of chlorine would also disrupt algal production; one of the main nutrient sources for many macroinvertebrates.

Although major organic pollution is not apparent in Dry Run Creek, it is just one of many components of urban runoff that could negatively impact Dry Run Creek. Urban storm runoff also contains many substances toxic to aquatic life such as salt from roads, polycyclic aromatic hydrocarbons from incomplete combustion of gas, coal or wood, and heavy metals such as lead, zinc, copper, cadmium and chromium. However, toxicity test with storm runoff effluents were all negative.

Scouring high water flows in Dry Run Creek during storm events are another factor potentially impacting Dry Run Creek's biota. Debris indicating high water could be found well outside the banks of all four sites, and CFU was affected by water levels in the Cedar River. Impervious surfaces such as parking lots and roads, coupled with storm sewers allow sudden, punctuated surges of water. These surges and the saltation of the associated bed load can scour macroinvertebrates and periphyton from the substrate, and, as they subside, deposit fine sediments in riffle interstices. During this study silt and sediment tended to occasionally partially fill the artificial substrates at all four sites. This was definitely apparent if there had been a large, heavy rain during the month. This effectively eliminates microhabitats necessary for a species-rich macroinvertebrate community and obscures the effects of chemical contamination (Arthington et al, 1982). A study by Blyth (1980) found siltation (due to damming) created a habitat for small oligochaetes and midge larvae but excluded many previously common stream insects. Also, these surges may rapidly increase temperatures. Many macroinvertebrates are intolerant of rapid temperature fluctuations.

Effluents flowing into Dry Run Creek may also be affecting downstream temperatures. Constant cold or warm water can adversely affect many macroinvertebrates. Most macroinvertebrates are adapted to diel temperature fluctuations of as much as 15°C. When these fluctuations are eliminated, such as below a low release dam, species richness drops dramatically. This lack of diel temperature fluctuation was most pronounced at Roth, and was probably due to the "tall grass prairie" effluent. Several effluents (including "tall grass prairie), when collected in cool weather, could be described as "bath water warm," and were not close to the ambient temperature in Dry Run Creek. During warmer weather the effluents were often much colder than the ambient temperature.

Overall, the effluent toxicity tests indicate that some effluents entering Dry Run Creek are toxic; apparently due to high chlorine concentrations. Given the volume of some of these effluents, such as the "tall grass prairie" effluent, even short-term episodes once or twice a year could prevent "normal" macroinvertebrate and periphyton communities from becoming established in Dry Run Creek. Until that toxicity is addressed, it will be difficult to determine what other stressors may be affecting Dry Run Creek. One possible solution to the chlorine problem and other potential problems (e.g., temperature, scouring surges, other toxicants) would be to run all effluents through retention basins or artificial wetlands before they enter Dry Run Creek.

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Dry Run Creek Sampling Sites

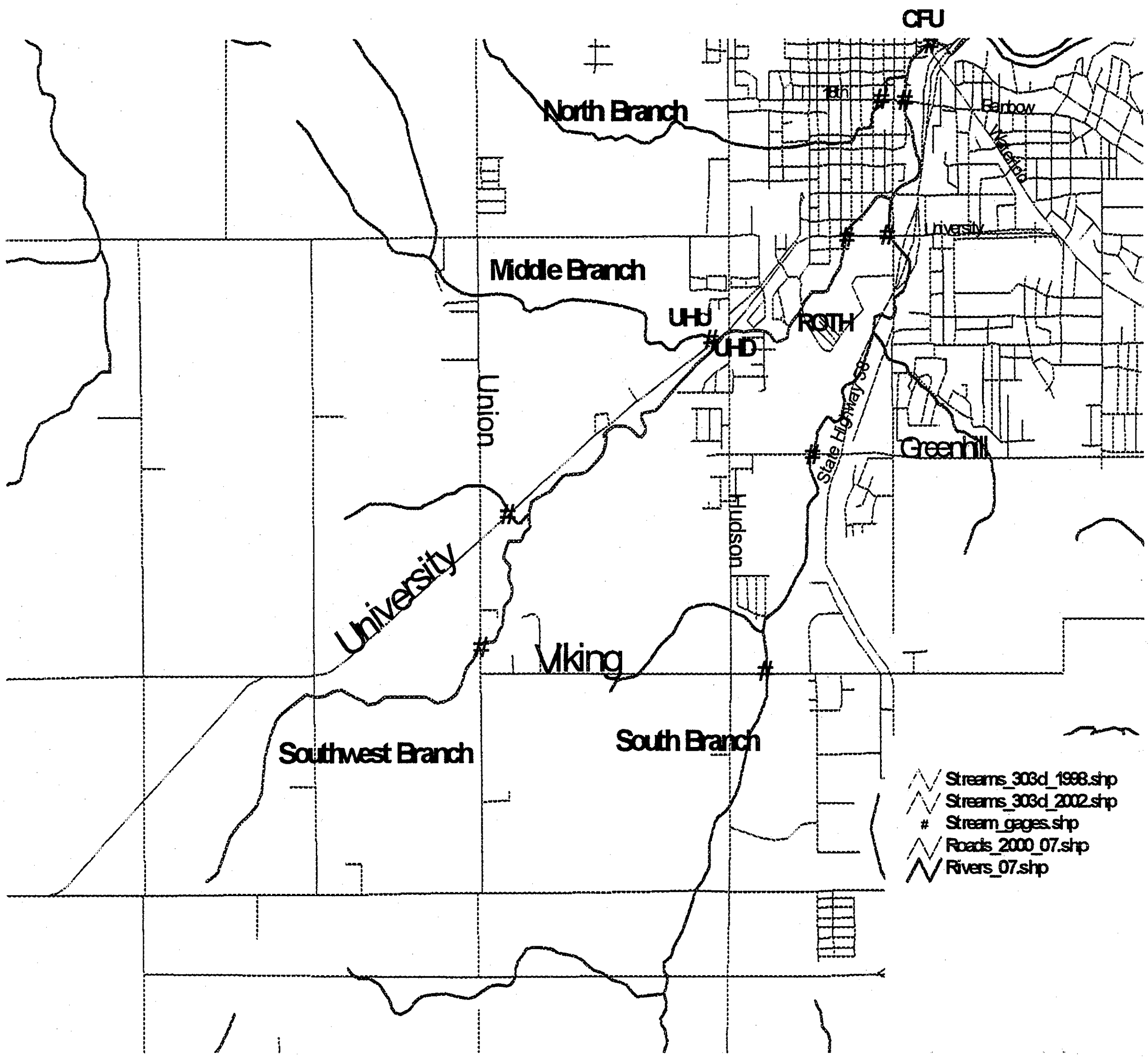

Fig. 1. Research site locations on Dry Run Creek from May 2006 to April 2007. UHU, UHD, and ROTH are all located on the middle branch. CFU is located upstream of where Dry Run Creek enters the Cedar River.

Table 1. Water Chemistry from Monthly Macroinvertebrate Collection Sites and In Situ Tests on Dry Run Creek.

Site	Date	Temp. °C	D.O. mg/L	Sal. ppt	pH	Cond. µS/cm	Hardness mg/L $CaCO_3$	Alkalinity mg/L $CaCO_3$	Discharge
UHU	5/10/2006	12.00	9.46	0.29	7.93	576	400	145	4.758 cfs
UHD	5/10/2006	12.23	9.85	0.3	7.76	573	321	116	2.292 cfs
Roth	5/10/2006	13.18	9.22	0.26	7.75	535	291	151	32.388 cfs
UHU	6/7/2006	19.74	7.37	0.3	7.88	582	302	136	
UHD	6/7/2006	20.25	8.21	0.3	7.99	586	311	132	
Roth	6/7/2006	17.78	9.25	0.28	8.08	542	295	243	
CFU	6/7/2006	19.40	9.35	0.28	8.44	521	289	212	
UHU	7/13/2006	19.83	6.33	0.3	8.02	579	316	189	
UHD	7/13/2006	19.89	6.73	0.3	7.93	579	322	204	
Roth	7/13/2006	18.34	8.1	0.28	7.88	549	285	207	
CFU	7/13/2006	18.97	8.77	0.26	8.22	521	286	215	
UHU	8/9/2006	20.78	5.83	0.29	7.89	575	318	204	
UHD	8/9/2006	21.29	5.84	0.29	7.93	565	281	202	
Roth	8/9/2006	17.38	8.19	0.27	8.21	536	295	240	
CFU	8/9/2006	20.73	7.86	0.18	8.39	359	194	148	
Cedar R.	8/15/2006	24.96	8.87	0.19	8.77	383	236	159	
UHU	9/14/2006	15.57	8.41	0.31	7.89	598	273	197	
UHD	9/14/2006	15.53	9.25	0.31	7.93	597	318	200	
Roth	9/14/2006	14.96	8.38	0.28	7.94	552	253	193	
CFU	9/14/2006	15.21	10.3	0.27	8.17	530	269	198	
Cedar R.	9/19/2006	13.65	11.54	0.26	8.39	515	263	206	
UHU	9/19/2006	12.47	11.68	0.32	7.92	625	342	199	
UHD	9/19/2006	12.91	11.44	0.32	7.88	621	336	212	
Roth	9/19/2006	12.89	12.64	0.29	7.98	561	278	208	
CFU	9/19/2006	12.63	11.46	0.28	8.21	549	286	196	
Cedar R.	9/25/2006	14.37	9.55	0.27	8.25	528	301	236	
UHU	9/25/2006	13.68	9.46	0.32	8.24	627	337	211	
UHD	9/25/2006	13.53	9.5	0.32	8.42	624	320	212	
Roth	9/25/2006	13.47	9.66	0.29	8.28	560	293	206	
CFU	9/25/2006	12.59	9.69	0.28	8.39	544	287	205	
UHU	10/10/2006	11.51	9.02	0.31	7.95	598	310	194	
UHD	10/10/2006	10.90	8.94	0.31	7.95	605	319	209	
Roth	10/10/2006	12.33	9.65	0.28	7.97	551	279	212	
CFU	10/10/2006	12.18	9.79	0.26	8.38	521	259	219	

Table 1 Continued. Water Chemistry from Monthly Macroinvertebrate Collection Sites and In Situ Tests on Dry Run Creek.

Site	Date	Temp. °C	D.O. mg/L	Sal. ppt	pH	Cond. µS/cm	Hardness mg/L $CaCO_3$	Alkalinity mg/L $CaCO_3$	Discharge
UHU	11/7/2006	9.02	8.1	0.31	8.11	609	299	197	1.999 cfs
UHD	11/7/2006	9.30	8.53	0.31	8.11	608	298	215	1.903 cfs
Roth	11/7/2006	9.29	9.13	0.31	8.14	597	328	189	6.750 cfs
CFU	11/7/2006	9.26	10.42	0.32	8.3	624	316	188	10.178 cfs
UHU	12/13/2006	2.89	12.14	0.3	7.86	586	331	213	2.848 cfs
UHD	12/13/2006	3.01	12.42	0.3	7.85	586	308	206	2.733 cfs
Roth	12/13/2006	3.49	13.09	0.29	7.95	576	312	211	5.371 cfs
CFU	12/13/2006	2.74	12.63	0.31	7.98	608	207	241	12.490 cfs
UHU	1/9/2007	2.74	12.7	0.3	8.05	587	342	198	2.789 cfs
UHD	1/9/2007	2.74	13.02	0.3	8.05	587	376	224	3.399 cfs
Roth	1/9/2007	2.20	12.91	0.29	8.18	572	321	213	9.369 cfs
CFU	1/9/2007	1.49	12.33	0.31	8.13	599	330	239	14.306 cfs
UHU	2/14/2007								
UHD	2/14/2007	6.46	10.84	0.29	8.9	585	323	215	5.392 cfs
Roth	2/14/2007	6.94	9.02	0.3	8.83	605	283	232	4.850 cfs
CFU	2/14/2007								
UHU	3/14/2007	7.14	9.74	0.22	9.12	435	234	166	20.695 cfs
UHD	3/14/2007	7.54	9.22	0.22	9.16	432	257	154	43.183 cfs
Roth	3/14/2007	7.88	8.78	0.22	8.95	434	202	130	65.252 cfs
CFU	3/14/2007								
UHU	4/10/2007	3.78	6.85	0.28	7.31	559	584	204	3.846 cfs
UHD	4/10/2007	3.84	7.21	0.29	7.11	561	381	191	4.656 cfs
Roth	4/10/2007	7.17	7.22	0.28	6.96	551	254	191	21.093 cfs
CFU	4/10/2007								
UHU	5/8/2007	11.06	5.03	0.28	8.03	550	301	187	6.064 cfs
UHD	5/8/2007	11.32	5.35	0.28	7.8	553	293	192	9.647 cfs
Roth	5/8/2007	13.14	4.92	0.27	7.72	540	261	189	37.050 cfs
CFU	5/8/2007								

Table 2. Weekly Max./Min. Temperature Readings from Dry Run Creek (°C).

Date	UHU	UHD	Roth	CFU
5/10/2006	15/11		16/13	
5/16/2006	20/10		16/13	
5/23/2006	20/10		15/10	
5/30/2006	29/14		20/15	
6/7/2006	23/16		19/15	
6/12/2006	24/9	28/9	18/13	37/12
6/21/2006	24/13	23/14	21/15	23/16
6/27/2006	23/16	23/15	19/16	23/16
7/13/2006	25/15	25/15	20/15	23/14
7/20/2006	28/19	27/19	22/17	28/17
7/26/2006	26/16	23/16	22/16	Broke
8/1/2006	30/21	28/20	22/18	
8/8/2006	27/17	25/17	23/17	25/17
8/15/2006	22/17	22/19	20/17	22/17
8/22/2006	23/16	22/18	19/16	25/16
8/30/2006	25/16	26/16	19/16	26/16
9/7/2006	22/14	22/14	17/15	22/13
9/14/2006	20/13	20/15	17/16	20/14
9/19/2006	21/17	20/13	18/14	21/11
9/26/2006	14/7	14/11	16/13	17/13
10/3/2006	23/5	22/10	20/14	22/9
10/10/2006	23/10	24/5	20/13	25/10
10/17/2006	11/0	12/3	13/13	14/4
10/24/2006	14/2	14/2	13/4	14/4
10/31/2006	14/2	14/2	12/2	13/2
11/7/2006	10/-3	10/-3	10/-3	10/1
11/14/2006	17/0	15/-2	14/-3	20/1
11/23/2006	10/0	8/-1	9/0	13/0
11/30/2006	5/-2	5/-2	5/-1	7/0
12/8/2006	3/-3	5/-3	5/-4	Frozen
12/13/2006	6/-1	6/0	7/0	2/0
12/21/2006	10/4	8/2	8/4	15/4
12/29/2006	6/0	7/1	6/-2	12/-1
1/5/2007	8/0	6/3	8/-3	Frozen
1/9/2007	6/0	7/-1	6/0	14/-1
1/25/2007	5/-1	5/-1	6/-5	Frozen
2/14/2007	Frozen	Frozen	Frozen	Frozen
2/20/2007 Reset	9/-9	7/-6	4/-15	Frozen
3/1/2007	8/2	7/2	6/1	Frozen
3/8/2007	6/1	6/2	7/4	11/0
3/14/2007	9/0	8/1	Broke	Frozen
3/23/2007	14/2	11/5	Reset	Flooded
3/29/2007	22/3	18/4	20/8	Flooded
4/5/2007	14/2	12/1	Broke	Flooded
4/10/2007	8/4	10/2		Flooded
4/19/2007	19/1	15/5	Reset	Flooded
4/27/2007	21/7	17/6	21/9	Flooded
5/3/2007	24/9	17/10	17/10	Broke
5/8/2007	19/10	23/12	15/10	

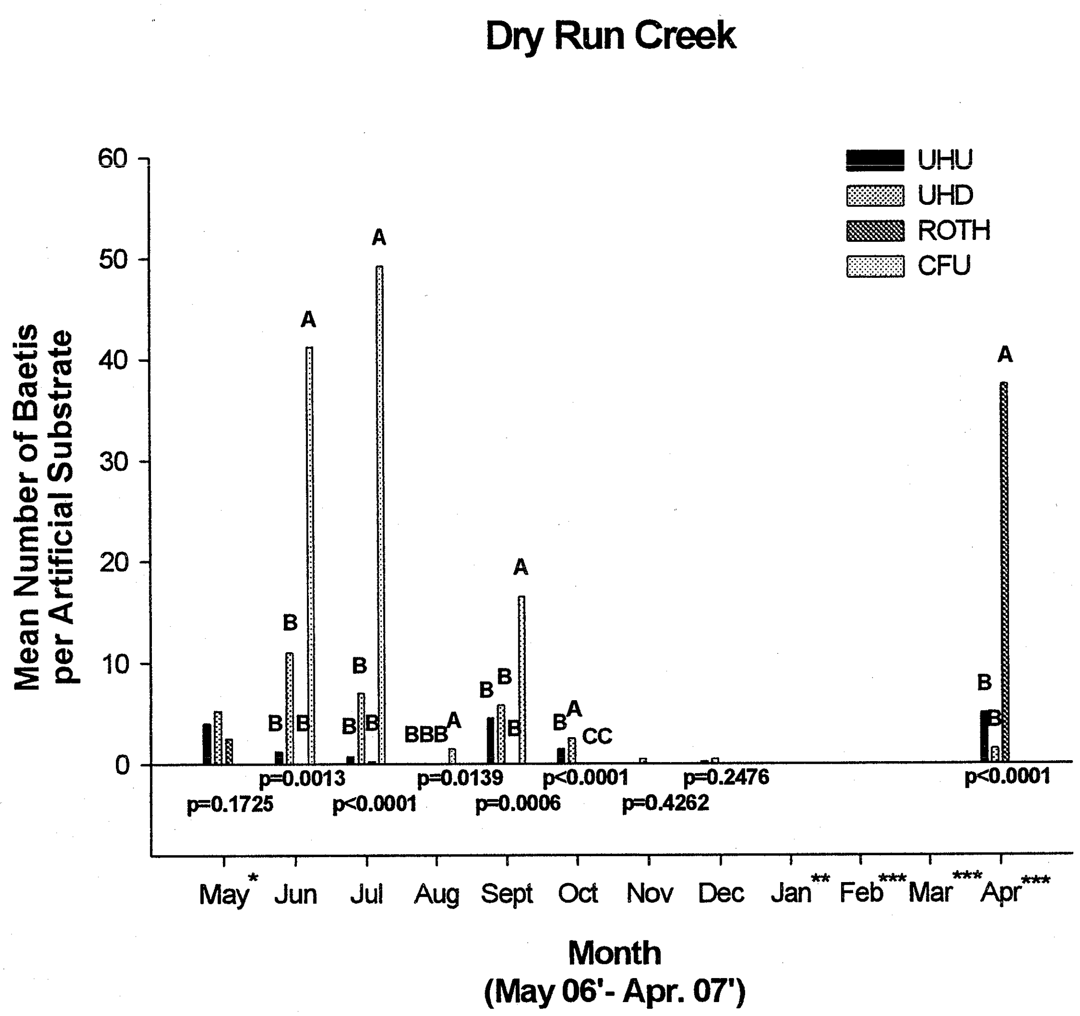

Fig. 2. Mean number of *Baetis* sp. per artificial substrate at four sites in Dry Run Creek (Iowa, USA). P values are from one-way ANOVA for each date among sites. Bars with the same letter are not significantly different (p>0.05) based on Duncan's Multiple Range Test for the separation of means.

*** = Site CFU was not set up because of flooding.**
**** = Sites UHU and CFU were frozen on collection date.**
***** = Site CFU was flooded on collection date.**

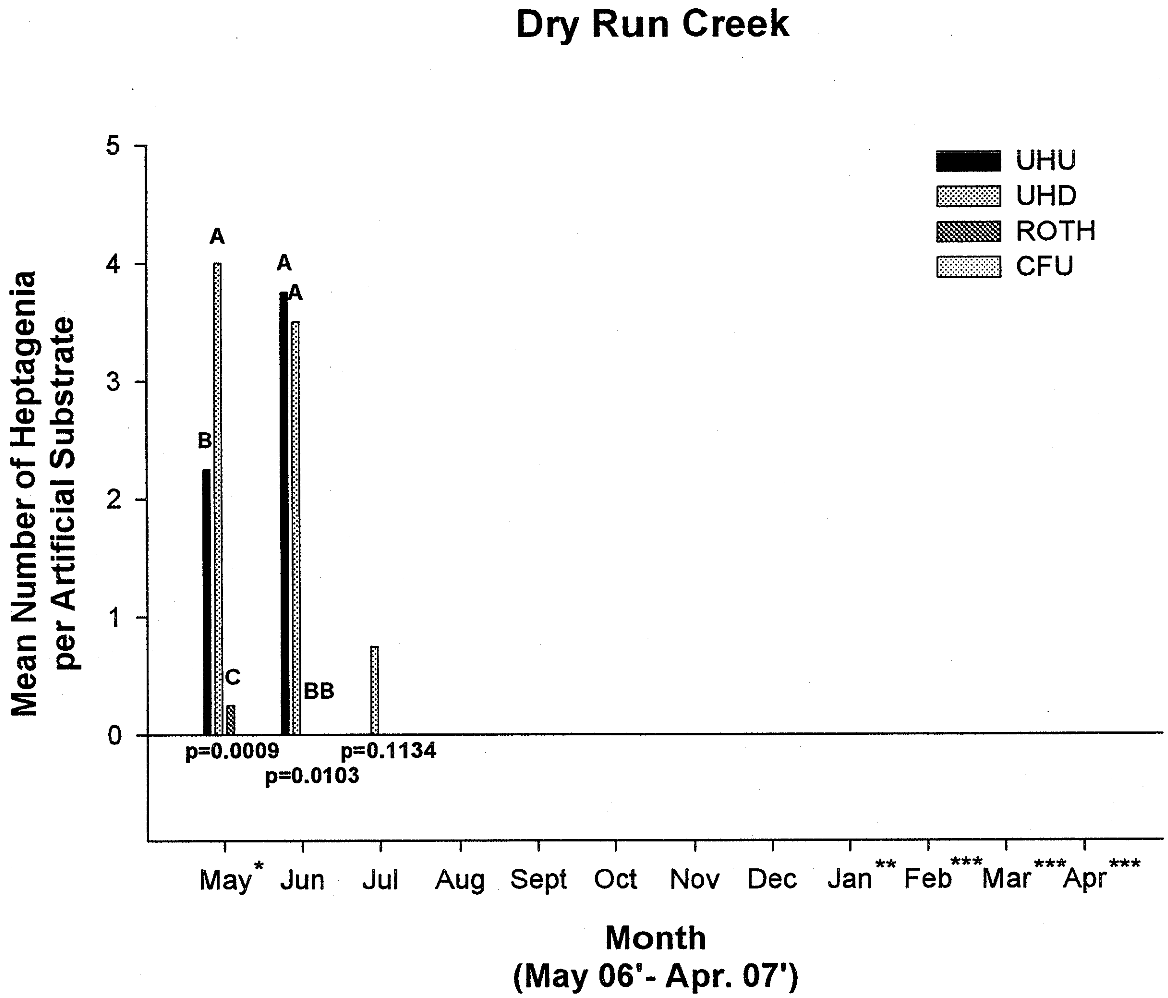

Fig. 3. Mean number of *Heptagenia* sp. per artificial substrate at four sites in Dry Run Creek (Iowa, USA). P values are from one-way ANOVA for each date among sites. Bars with the same letter are not significantly different (p>0.05) based on Duncan's Multiple Range Test for the separation of means.

*** = Site CFU was not set up because of flooding.**
**** = Sites UHU and CFU were frozen on collection date.**
***** = Site CFU was flooded on collection date.**

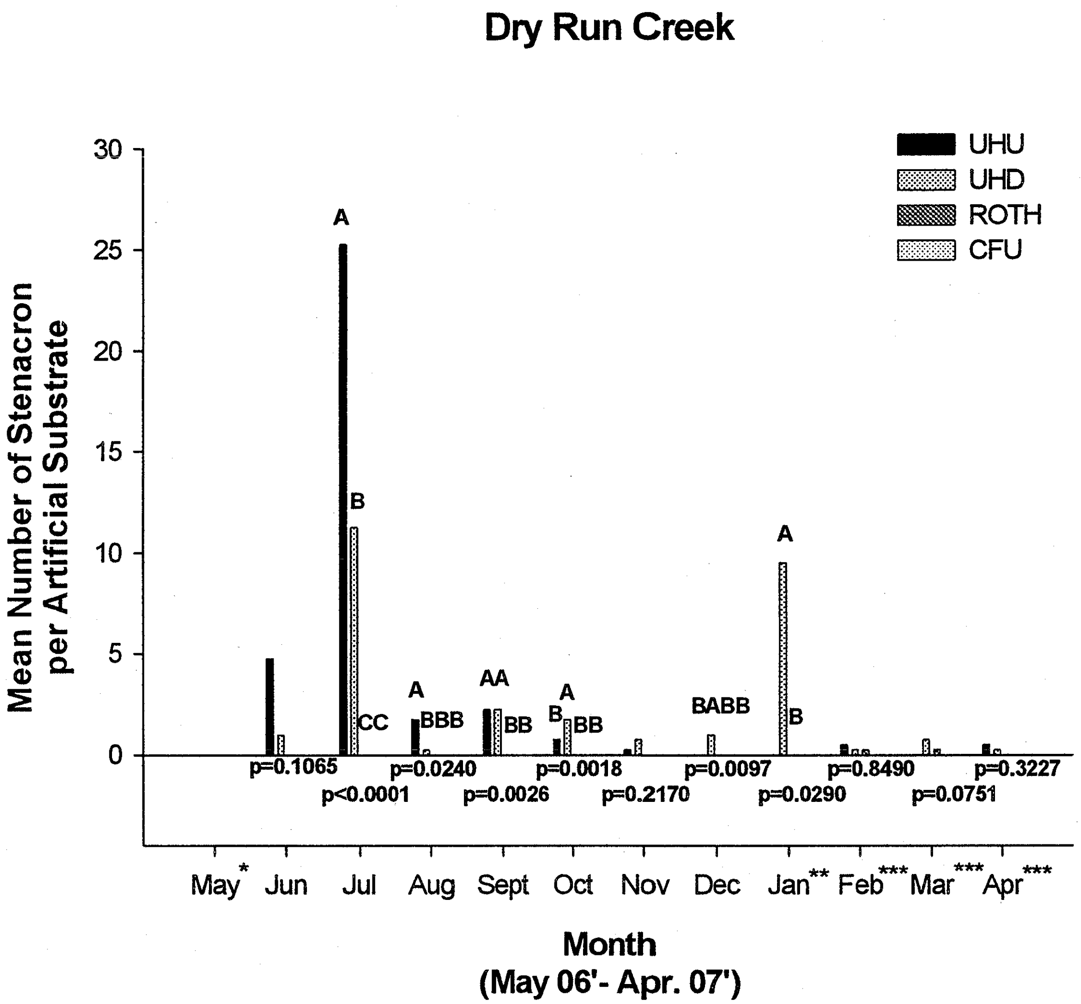

Fig. 4. Mean number of *Stenacron* sp. per artificial substrate at three sites in Dry Run Creek (Iowa, USA). P values are from one-way ANOVA for each date among sites. Bars with the same letter are not significantly different (p>0.05) based on Duncan's Multiple Range Test for the separation of means.

*** = Site CFU was not set up because of flooding.**
**** = Sites UHU and CFU were frozen on collection date.**
***** = Site CFU was flooded on collection date.**

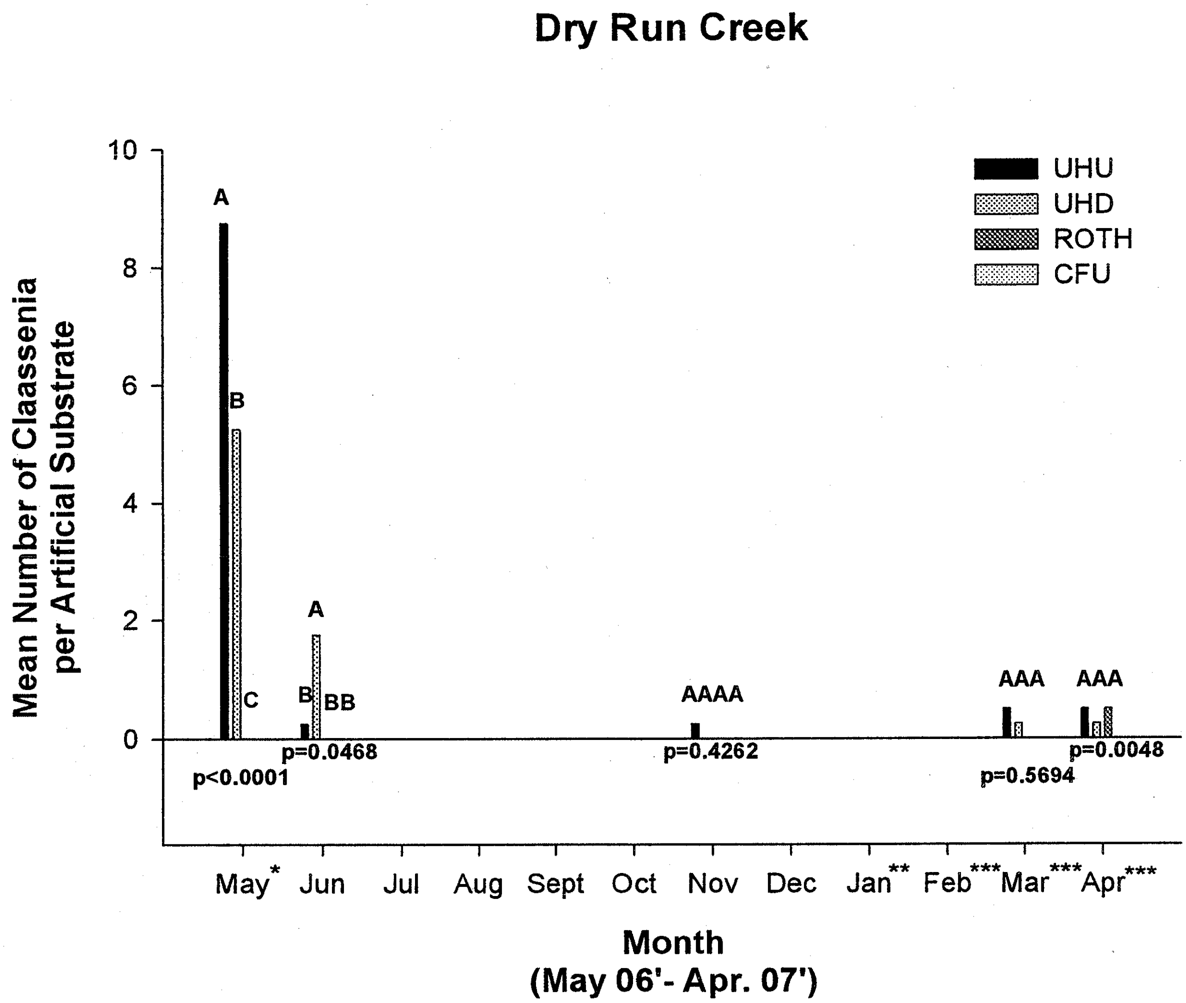

Fig. 5. Mean number of *Claassenia* sp. per artificial substrate at four sites in Dry Run Creek (Iowa, USA). P values are from one-way ANOVA for each date among sites. Bars with the same letter are not significantly different (p>0.05) based on Duncan's Multiple Range Test for the separation of means.

*** = Site CFU was not set up because of flooding.**
**** = Sites UHU and CFU were frozen on collection date.**
***** = Site CFU was flooded on collection date.**

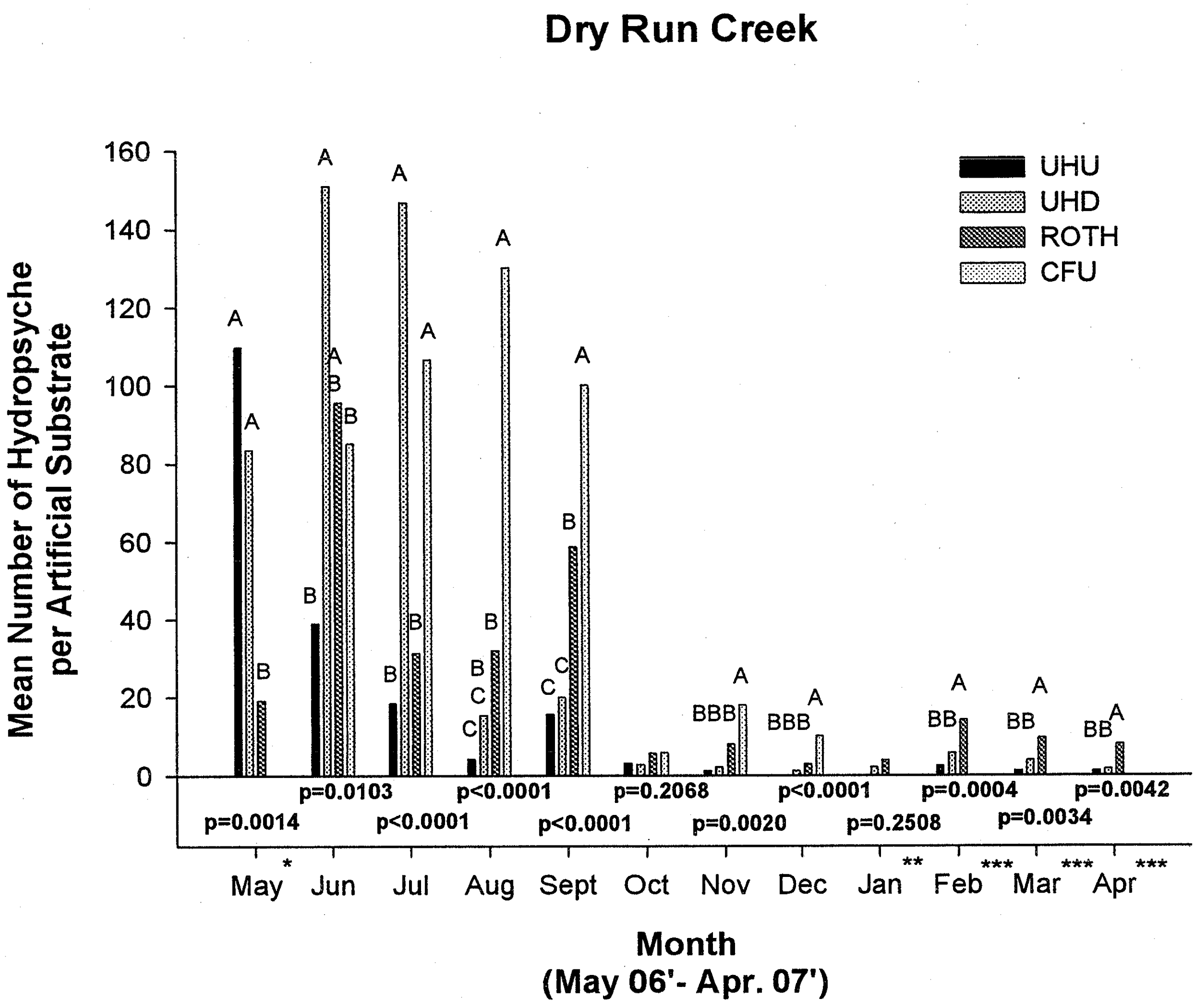

Fig. 6. Mean number of *Hydropsyche* sp. per artificial substrate at four sites in Dry Run Creek (Iowa, USA). P values are from one-way ANOVA for each date among sites. Bars with the same letter are not significantly different (p>0.05) based on Duncan's Multiple Range Test for the separation of means.

*** = Site CFU was not set up because of flooding.**
**** = Sites UHU and CFU were frozen on collection date.**
***** = Site CFU was flooded on collection date.**

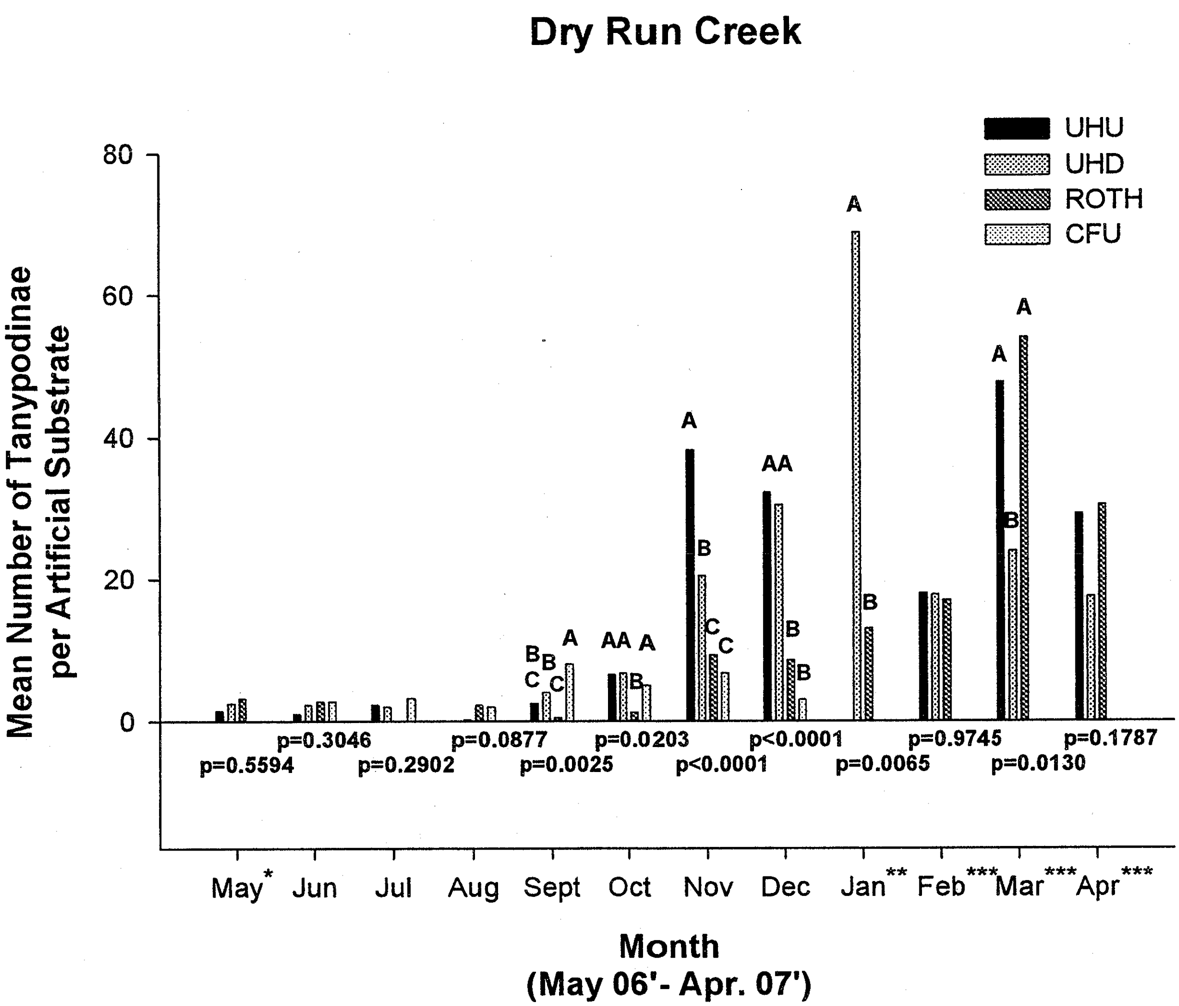

Fig. 7. Mean number of Tanypodinae per artificial substrate at four sites in Dry Run Creek (Iowa, USA). P values are from one-way ANOVA for each date among sites. Bars with the same letter are not significantly different (p>0.05) based on Duncan's Multiple Range Test for the separation of means.

*** = Site CFU was not set up because of flooding.**
**** = Sites UHU and CFU were frozen on collection date.**
***** = Site CFU was flooded on collection date.**

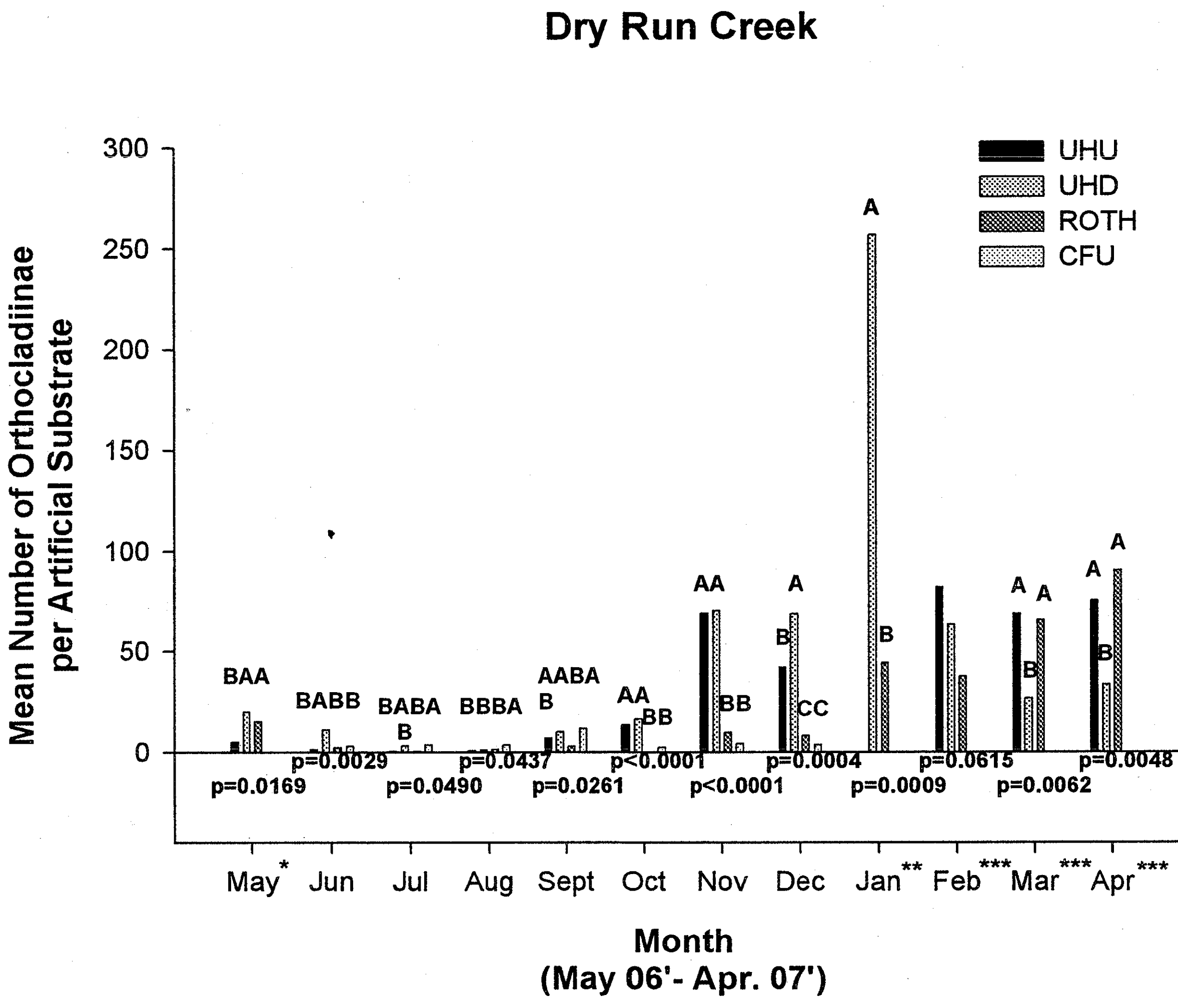

Fig. 8. Mean number of Orthocladiinae per artificial substrate at four sites in Dry Run Creek (Iowa, USA). P values are from one-way ANOVA for each date among sites. Bars with the same letter are not significantly different (p>0.05) based on Duncan's Multiple Range Test for the separation of means.

*** = Site CFU was not set up because of flooding.**
**** = Sites UHU and CFU were frozen on collection date.**
***** = Site CFU was flooded on collection date.**

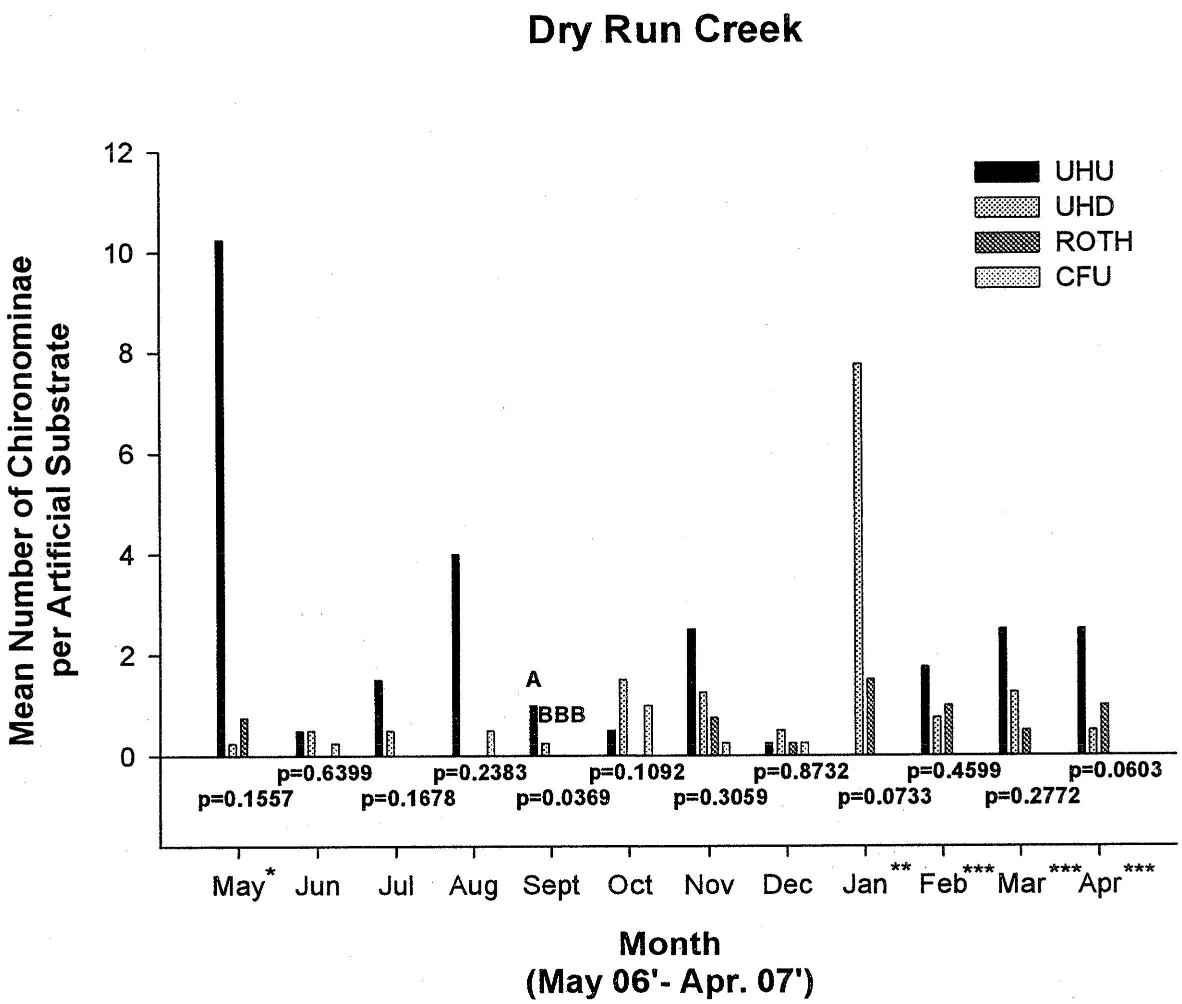

Fig. 9. Mean number of Chironominae per artificial substrate at four sites in Dry Run Creek (Iowa, USA). P values are from one-way ANOVA for each date among sites. Bars with the same letter are not significantly different (p>0.05) based on Duncan's Multiple Range Test for the separation of means.

*** = Site CFU was not set up because of flooding.**
**** = Sites UHU and CFU were frozen on collection date.**
***** = Site CFU was flooded on collection date.**

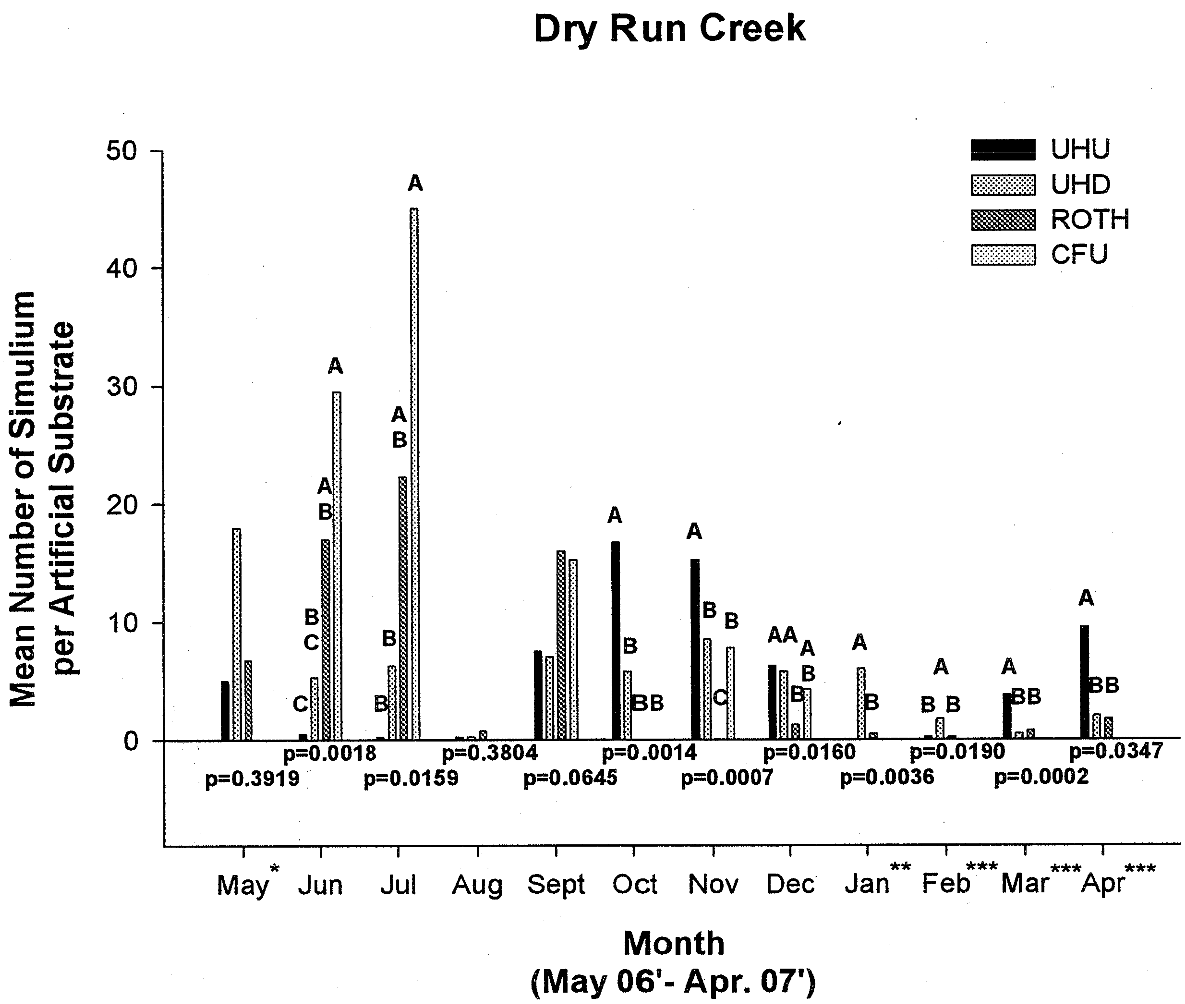

Fig. 10. Mean number of *Simulium* sp. per artificial substrate at four sites in Dry Run Creek (Iowa, USA). P values are from one-way ANOVA for each date among sites. Bars with the same letter are not significantly different (p>0.05) based on Duncan's Multiple Range Test for the separation of means.

*** = Site CFU was not set up because of flooding.**
**** = Sites UHU and CFU were frozen on collection date.**
***** = Site CFU was flooded on collection date.**

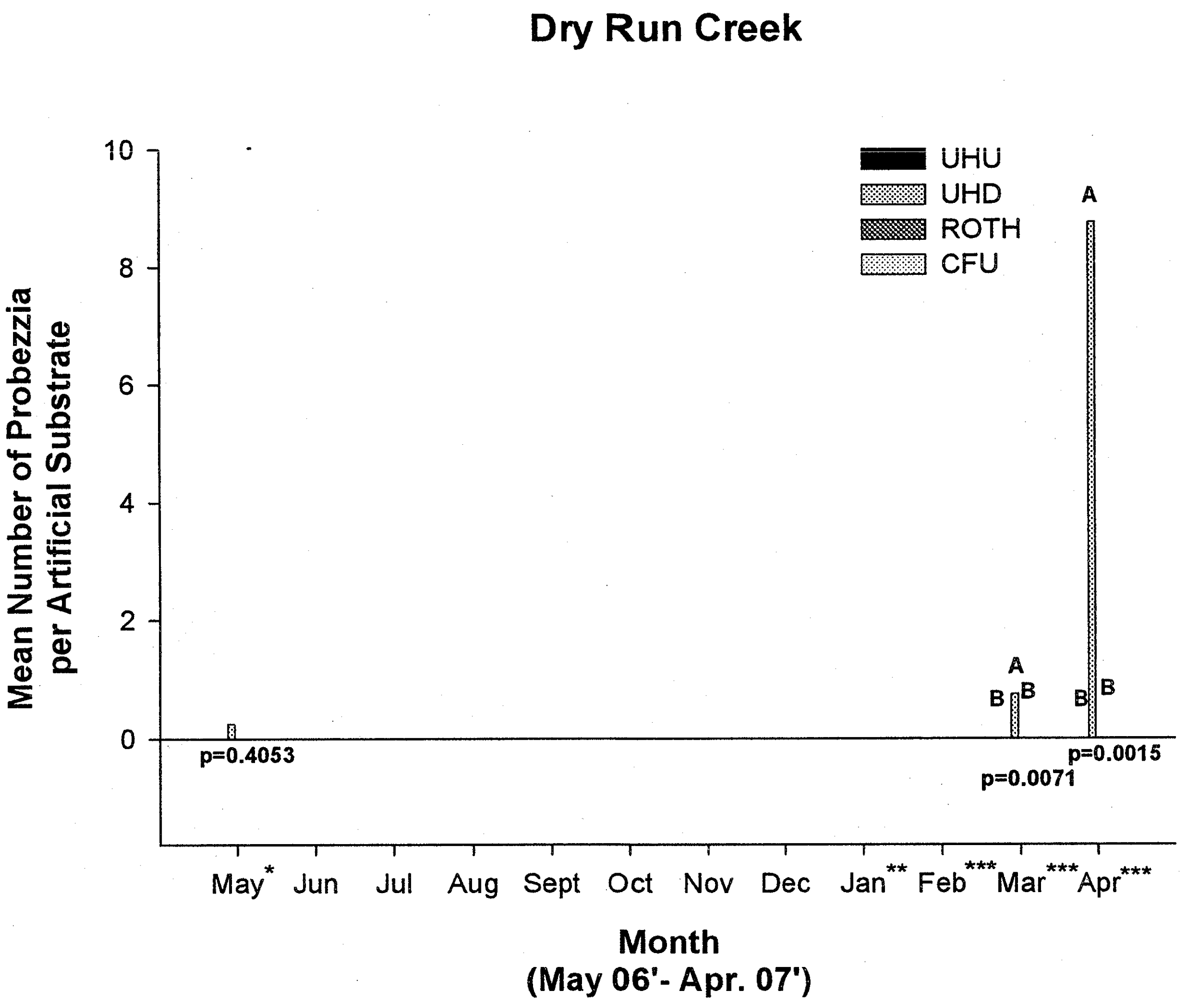

Fig. 11. Mean number of *Probezzzia* sp. per artificial substrate at four sites in Dry Run Creek (Iowa, USA). P values are from one-way ANOVA for each date among sites. Bars with the same letter are not significantly different (p>0.05) based on Duncan's Multiple Range Test for the separation of means.

*** = Site CFU was not set up because of flooding.**
**** = Sites UHU and CFU were frozen on collection date.**
***** = Site CFU was flooded on collection date.**

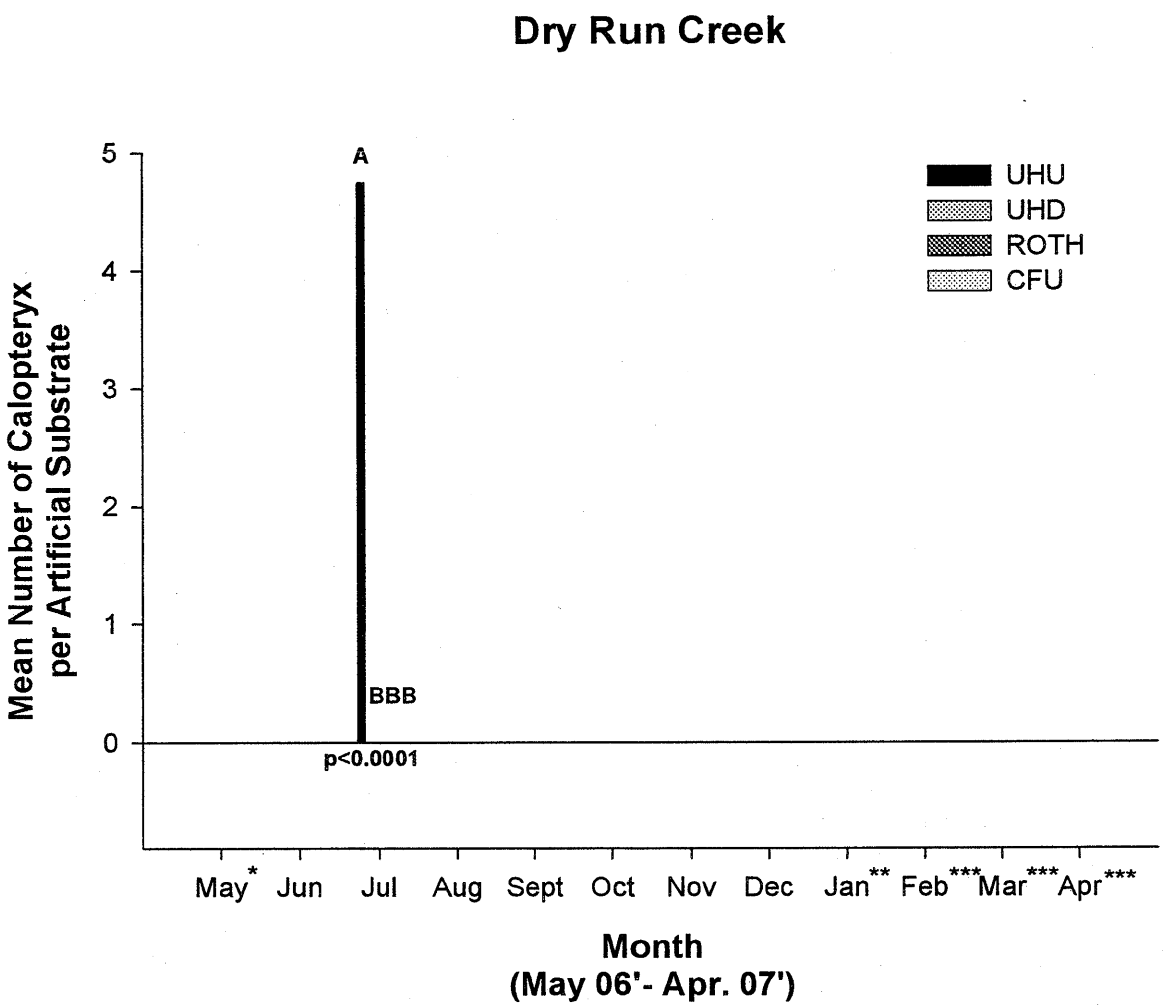

Fig. 12. Mean number of *Calopteryx* sp. per artificial substrate at four sites in Dry Run Creek (Iowa, USA). P values are from one-way ANOVA for each date among sites. Bars with the same letter are not significantly different (p>0.05) based on Duncan's Multiple Range Test for the separation of means.

*** = Site CFU was not set up because of flooding.**
**** = Sites UHU and CFU were frozen on collection date.**
***** = Site CFU was flooded on collection date.**

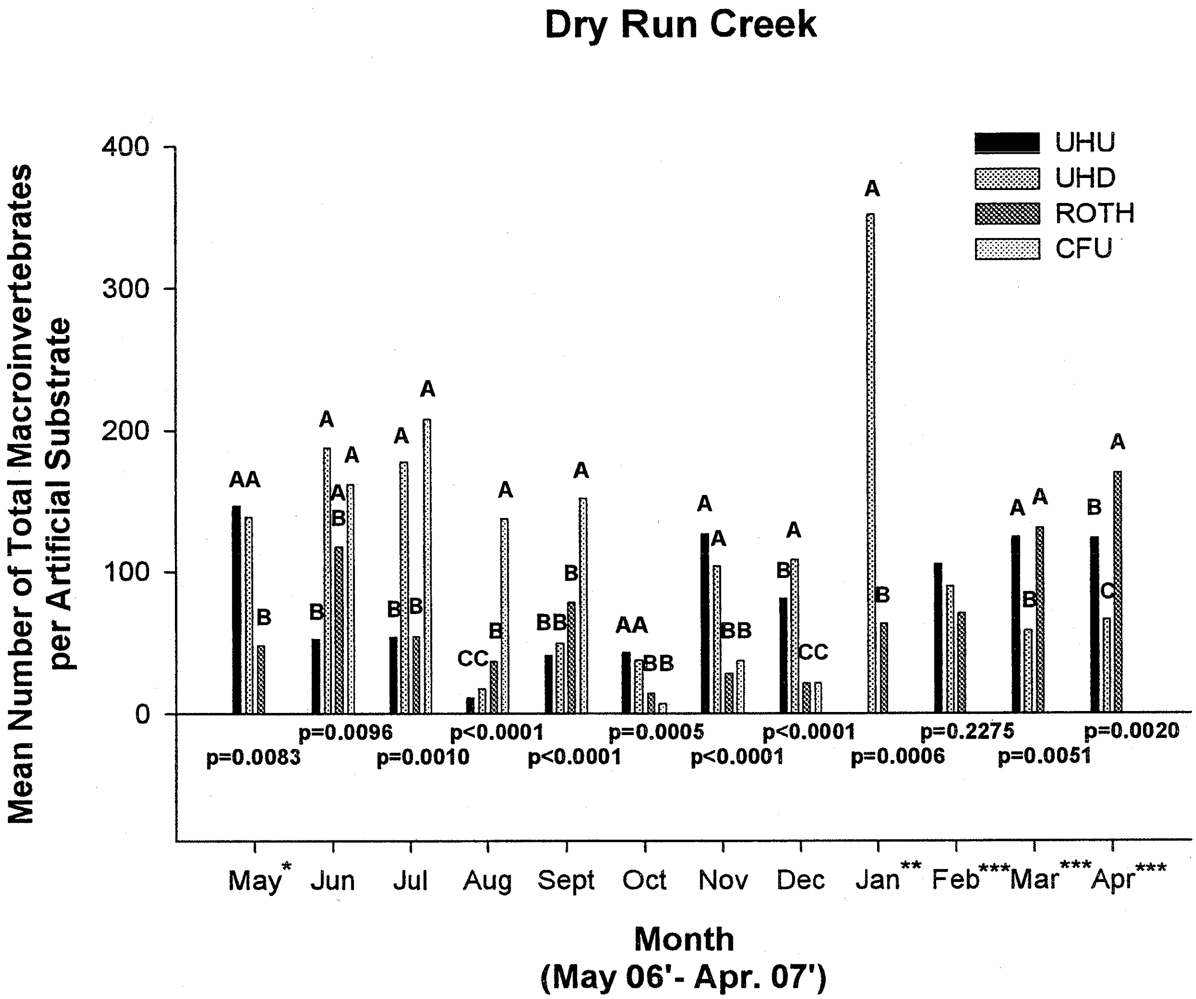

Fig. 13. Mean number of total macroinvertebrates per artificial substrate at four sites in Dry Run Creek (Iowa, USA). P values are from one-way ANOVA for each date among sites. Bars with the same letter are not significantly different (p>0.05) based on Duncan's Multiple Range Test for the separation of means.

*** = Site CFU was not set up because of flooding.**
**** = Sites UHU and CFU were frozen on collection date.**
***** = Site CFU was flooded on collection date.**

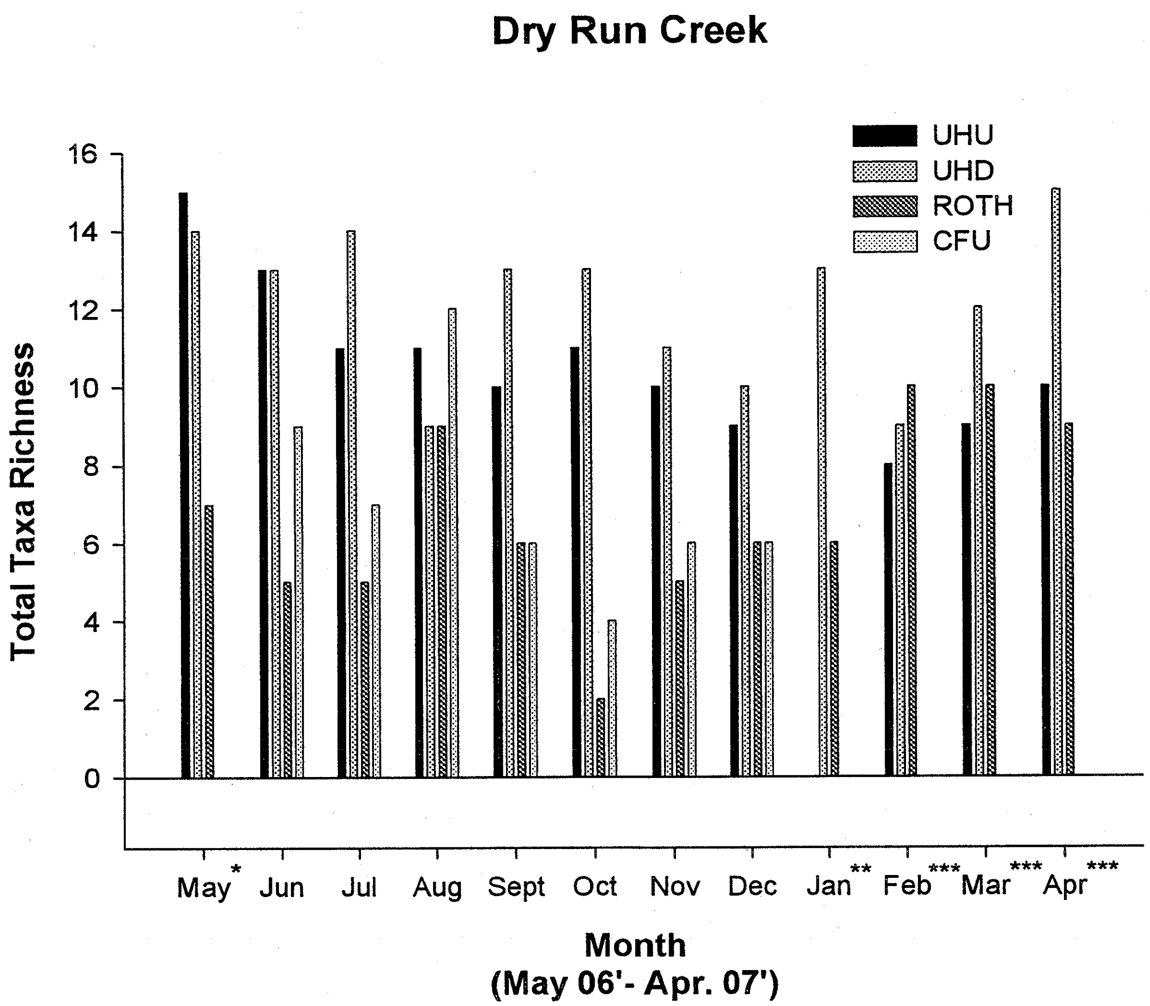

Fig. 14. Total taxa richness found at each site in Dry Run Creek (Iowa, USA).

*** = Site CFU was not set up because of flooding.**
**** = Sites UHU and CFU were frozen on collection date.**
***** = Site CFU was flooded on collection date.**

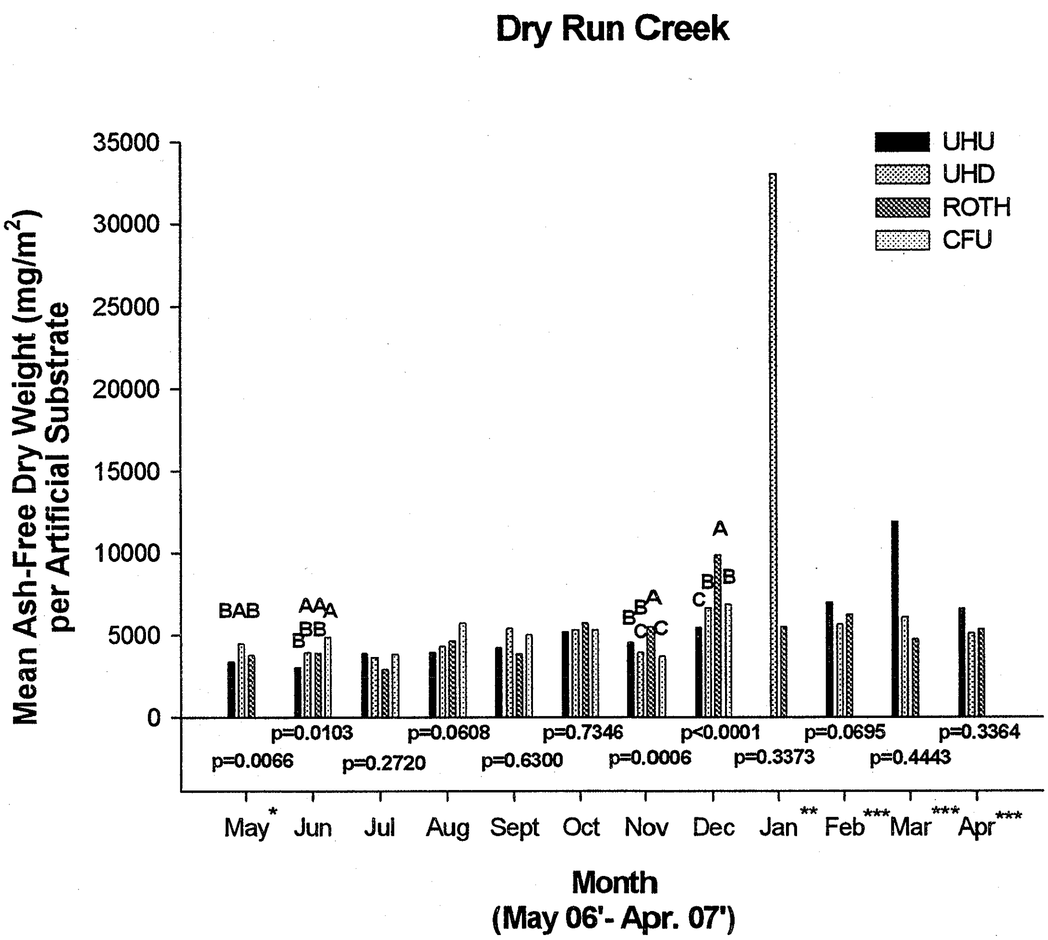

Fig. 15. Mean ash-free dry weight (mg/m²) per artificial substrate at four sites in Dry Run Creek (Iowa, USA). P values are from one-way ANOVA for each date among sites. Bars with the same letter are not significantly different (p>0.05) based on Duncan's Multiple Range Test for the separation of means.

*** = Site CFU was not set up because of flooding.**
**** = Sites UHU and CFU were frozen on collection date.**
***** = Site CFU was flooded on collection date.**

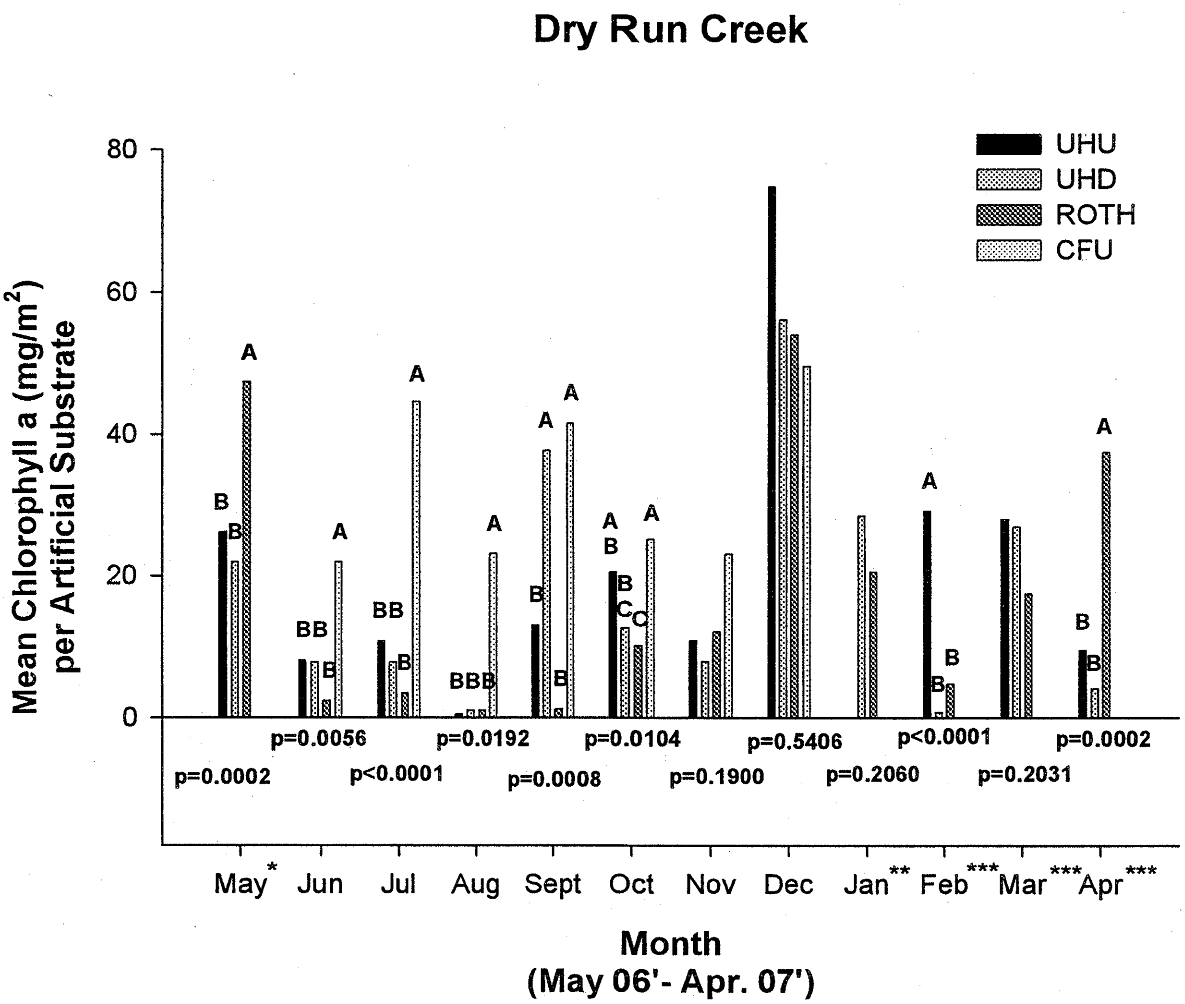

Fig. 16. Mean chlorophyll a (mg/m²) per artificial substrate at four sites in Dry Run Creek (Iowa, USA). P values are from one-way ANOVA for each date among sites. Bars with the same letter are not significantly different (p>0.05) based on Duncan's Multiple Range Test for the separation of means.

*** = Site CFU was not set up because of flooding.**
**** = Sites UHU and CFU were frozen on collection date.**
***** = Site CFU was flooded on collection date.**

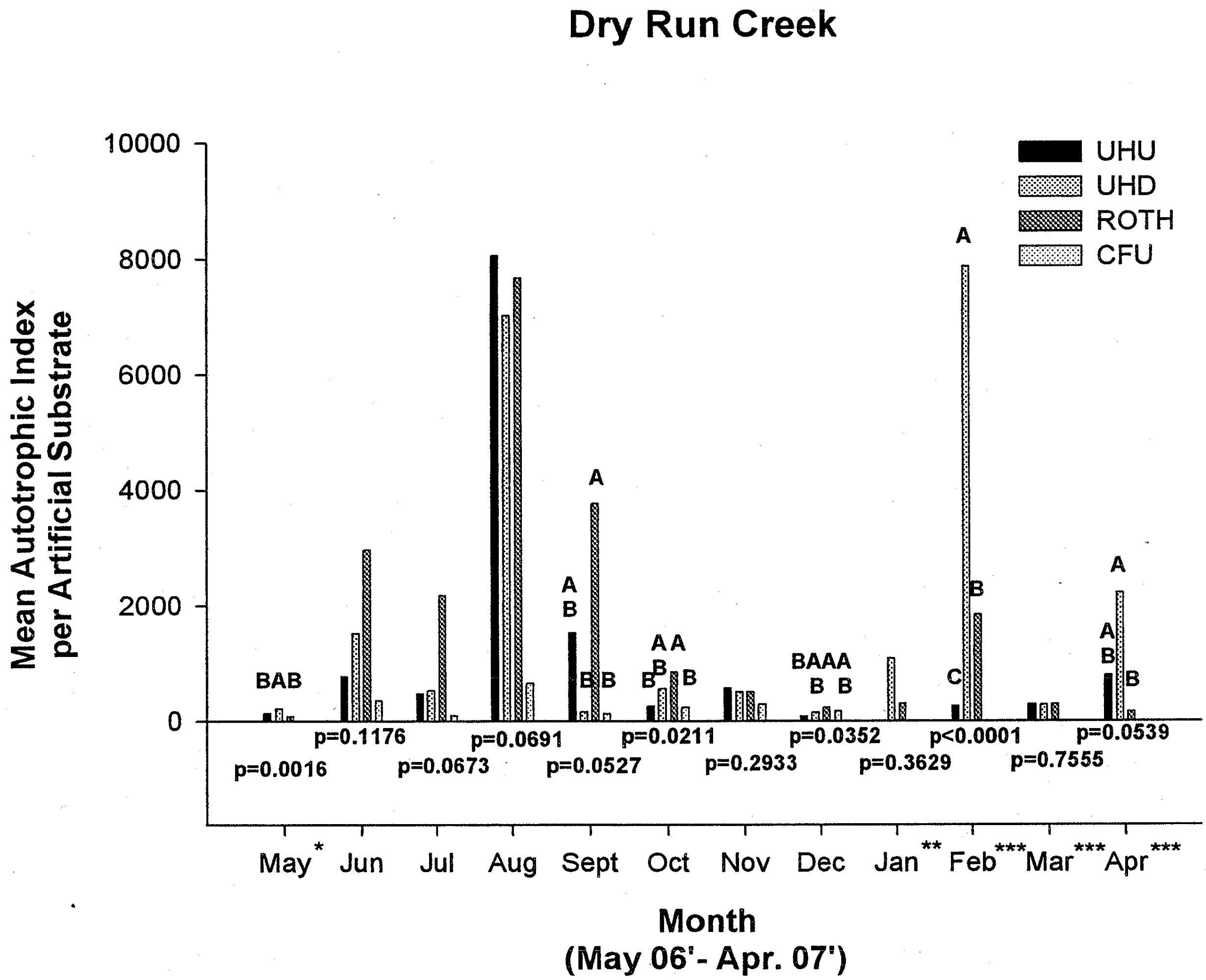

Fig. 17. Mean Autotrophic Index per artificial substrate at four sites in Dry Run Creek (Iowa, USA). P values are from one-way ANOVA for each date among sites. Bars with the same letter are not significantly different (p>0.05) based on Duncan's Multiple Range Test for the separation of means.

*** = Site CFU was not set up because of flooding.**
**** = Sites UHU and CFU were frozen on collection date.**
***** = Site CFU was flooded on collection date.**

Table 3. Effluent Sampling Sites on Dry Run Creek.

University/Hudson (Erickson Automotive)
N 42.50661
W 92.46786

South of Lutheran Home
N 42.51198
W 92.45064

Westminister 1 (2 pipes - R & L) (Industrial Park)
N 42.49041
W 92.45643

Dog Park
N 42.50923
W 92.44324

UNI Dome Parking Lot
N 42.52010
W 92.46802

UNI Towers
N 42.51917
W 92.46162

UBE (Lutheran Home Area)
N 42.51288
W 92.45051

UBW (Lutheran Home Area)
N 42.51287
W 92.45055

Roth Biological Preserve
N 42.50955
W 92.45257

Mark's Tot Lot Park (MTLP)
N 42.50662
W 92.46319

Table 3 Continued. Effluent Sampling Sites on Dry Run Creek.

Panther Lane
N 42.50697
W 92.46117

UNI Tennis Courts NE
N 42.51922
W 92.46336

UNI Tennis Courts NW
N 42.51936
W 92.46495

UNI New Energy Center
N 42.50666
W 92.45712

Tallgrass Prairie
N 42.50910
W 92.45431

Westminister 2 (Industrial Park)
N 42.55095
W 92.43459

Campus Street Bridge
N 42.51899
W 92.46045

Westminister 3 (Industrial Park)
N 42.48818
W 92.45858

Table 4. Effluent Water Chemistry on Dry Run Creek.

Site	Date	Temp. °C	D.O. mg/L	Sal. ppt	pH	Cond. µS/cm	Hardness mg/L $CaCO_3$	Alkalinity mg/L $CaCO_3$
Control	5/17/2006	19.58	8.51	0.16	8.16	326	166	83
Roth Preserve	5/17/2006	22.00	8.95	0.28	7.96	545	281	148
Univ./Hudson	5/17/2006	21.73	8.15	0.67	7.74	1262	570	165
Lutheran S.	5/17/2006	21.69	8.93	0.28	7.93	543	292	140
Univ. Bridge E.	5/17/2006	21.62	9.31	0.24	7.86	481	251	143
Univ. Bridge W.	5/17/2006	21.74	8.85	0.23	7.95	465	254	160
UNI Towers	5/17/2006	21.76	8.54	0.31	7.74	612	272	172
Westminister 1	5/17/2006	21.80	9.04	0.46	7.84	890	326	154
Dog Park	5/17/2006	21.87	8.98	0.36	7.96	704	316	149
UNI Dome PL	5/17/2006	21.96	8.36	0.2	8.02	406	234	157
Control	6/13/2006	19.88	8.65	0.17	8.2	343	202	148
Roth Preserve	6/13/2006	20.74	8.83	0.27	7.93	534	292	213
Univ./Hudson	6/13/2006	NO Effluent						
Univ. Bridge E.	6/13/2006	20.86	8.63	0.32	8.03	623	316	212
Univ. Bridge W.	6/13/2006	20.86	8.56	0.28	8.01	555	281	203
UNI Towers	6/13/2006	20.94	8.5	0.32	7.94	620	316	206
Westminister 1	6/13/2006	20.89	8.22	0.55	7.8	1050	457	212
Dog Park	6/13/2006	20.74	8.45	0.36	7.68	665	341	207
UNI Dome PL	6/13/2006	20.89	8.35	0.2	8.11	403	248	218
Control	6/22/2006	20.22	8.71	0.17	8.26	345	167	108
Roth Preserve	6/22/2006	20.59	8.52	0.28	7.95	540	274	209
Cedar River	6/22/2006	23.59	7.97	0.26	8.07	518	276	200
DRC 18th/Main	6/22/2006	21.59	8.93	0.23	8.02	453	247	211
Westminister 1	6/22/2006	21.60	7.86	0.53	7.81	1007	359	215
Dog Park	6/22/2006	21.52	8.72	0.34	7.91	668	322	213
UNI Dome PL	6/22/2006	23.40	7.57	0.2	7.95	410	236	222
Control	7/12/2006 Collected	21.25	8.11	0.19	8.25	375	137	105
Roth Preserve	7/12/2006 11-Jul	23.04	7.21	0.14	8.08	287	131	92
Univ./Hudson	7/12/2006 after a	23.06	7.26	0.12	8.07	260	82	52
Univ. Bridge E.	7/12/2006 storm	23.15	6.87	0.05	8.04	115	52	50
Univ. Bridge W.	7/12/2006	23.05	5.87	0.08	8.11	171	64	71
UNI Towers	7/12/2006	23.09	7.82	0.05	7.72	624	301	199
Westminister 1	7/12/2006	23.00	7.35	0.1	8.08	213	76	80
Dog Park	7/12/2006	23.18	6.88	0.07	7.94	164	69	53
UNI Dome PL	7/12/2006	23.18	7.46	0.21	7.94	413	229	215
Control	8/8/2006	20.74	8.44	0.19	8.27	391	168	113
Dog Park	8/8/2006	23.70	7.19	0.34	7.92	668	304	210
Westminister 1	8/8/2006	24.09	7.00	0.55	7.81	1054	415	198
Univ./Hudson	8/8/2006	25.49	7.24	0.23	7.91	464	231	192
Roth Preserve	8/8/2006	23.57	7.98	0.28	7.85	551	295	221
UNI Dome PL	8/8/2006	24.94	7.17	0.21	7.91	415	241	214
UNI Towers	8/8/2006	27.30	6.81	0.26	7.81	521	265	218
Univ. Bridge E.	8/8/2006	24.94	7.34	0.25	7.85	485	251	191
Univ. Bridge W.	8/8/2006	23.56	7.96	0.28	7.87	547	277	213

Table 4 Continued. Effluent Water Chemistry on Dry Run Creek.

Site	Date	Temp °C	D.O. mg/L	Sal. ppt	pH	Cond. µS/cm	Hardness mg/L $CaCO_3$	Alkalinity mg/L $CaCO_3$
Control	9/15/2006	20.04	8.02	0.18	8.52	371	188	119
Univ. Bridge E.	9/15/2006	21.67	7.73	0.34	8.16	654	321	212
Univ. Bridge W.	9/15/2006	21.76	7.63	0.33	8.27	634	317	198
Univ./Hudson	9/15/2006	21.83	7.61	0.32	8.18	632	303	192
Westminister 1	9/15/2006	21.76	7.86	0.33	8.13	643	272	155
Westminister 2	9/15/2006	21.69	7.75	0.51	8.13	982	363	396
UNI Towers	9/15/2006	21.94	7.74	0.42	8.14	817	351	204
Control	10/17/2006	17.06	7.37	0.18	8.35	357	157	90
New Energy C.	10/17/2006	15.76	8.40	0.3	8.29	596	312	184
Univ./Hudson	10/17/2006	19.15	7.54	0.24	8.06	476	262	187
Tennis C. NE	10/17/2006	15.08	8.67	0.2	8.15	414	247	190
Tennis C. NW	10/17/2006	16.06	8.40	0.21	8.21	423	243	197
UNI Towers	10/17/2006	19.84	6.95	0.26	7.9	518	254	197
Univ. Bridge E.	10/17/2006	17.20	7.79	0.27	8.06	533	281	194
Univ. Bridge W.	10/17/2006	15.05	8.31	0.3	8.17	592	309	187
Tall Grass Prairie	10/17/2006	14.69	8.66	0.3	8.02	589	316	197
Control	11/14/2006	17.54	7.73	0.15	8.44	307	136	107
Tall Grass Prairie	11/14/2006	12.89	8.59	0.29	8.41	576	313	209
Tennis C. NE	11/14/2006	10.34	9.12	0.38	8.25	736	334	171
Univ. Bridge W.	11/14/2006	12.77	8.95	0.33	8.39	642	330	189
Panther Lane	11/14/2006	14.07	8.48	0.25	8.19	496	260	120
Univ. Bridge E.	11/14/2006	14.35	8.11	0.23	8.17	451	267	193
Univ./Hudson	11/14/2006	14.12	8.30	0.26	8.12	509	264	193
UNI Towers	11/14/2006	14.12	8.41	0.86	8.04	1633	533	231
MTLP	11/14/2006	14.38	8.32	0.67	7.99	1269	512	215
Control	12/18/2006	18.56	8.42	0.19	8.58	380	215	177
Tall Grass Prairie	12/18/2006	12.74	9.54	0.28	8.36	545	280	205
MTLP	12/18/2006	10.61	10.21	1.01	8.19	1904	845	277
Panther Lane	12/18/2006	9.92	10.84	0.24	8.33	480	252	127
Univ. Bridge E.	12/18/2006	13.28	9.03	0.22	8.2	436	257	206
Campus Street	12/18/2006	9.74	10.82	0.72	8.12	1357	490	197
Univ./Hudson	12/18/2006	13.35	8.84	0.26	8.16	503	283	205
Control	1/17/2007	19.01	7.03	0.16	8.86	323	146	113
Campus St.	1/17/2007	22.39	6.95	0.89	8.33	1668	502	193
Univ. Bridge E.	1/17/2007	21.91	7.08	0.32	8.46	630	458	216
Univ./Hudson	1/17/2007	21.32	6.94	0.24	8.48	468	255	196
MTLP	1/17/2007	21.46	7.18	1.11	8.17	2076	717	288
Panther Lane	1/17/2007	21.50	7.34	0.24	8.33	478	228	123
Tall Grass Prairie	1/17/2007	21.50	7.10	0.29	8.27	578	277	205
Control	2/21/2007	21.42	7.15	0.16	8.82	336	151	110
UNI Towers	2/21/2007	24.03	2.86	0.14	8.29	289	79	46
MTLP	2/21/2007	23.58	6.12	2.90	8.21	5266	505	205
Univ. Bridge E.	2/21/2007	23.46	6.59	0.39	8.38	746	314	212
Univ./Hudson	2/21/2007	23.26	6.60	0.52	8.55	987	296	212

Table 4 Continued. Effluent Water Chemistry on Dry Run Creek.

Site	Date		Temp °C	D.O. mg/L	Sal. ppt	pH	Cond. µS/cm	Hardness mg/L $CaCO_3$	Alkalinity mg/L $CaCO_3$
Campus St.	2/21/2007		23.29	6.29	1.03	8.46	1932	217	92
Panther Lane	2/21/2007		23.34	6.86	0.37	8.41	718	232	131
Tall Grass Prairie	2/21/2007		23.39	6.93	0.29	8.61	563	263	204
Control	3/20/2007		19.22	6.75	0.17	7.60	338	145	103
Tall Grass Prairie	3/20/2007		16.81	7.03	0.29	7.50	564	291	230
UNI Towers	3/20/2007		13.51	7.81	0.91	7.47	1714	567	206
Panther Lane	3/20/2007		13.85	7.89	0.22	7.46	441	231	118
MTLP	3/20/2007		14.91	7.67	1.27	7.24	2366	802	266
Univ. Bridge E.	3/20/2007		16.18	7.17	0.28	7.32	558	280	198
Westminister 3	3/20/2007		14.94	7.86	0.58	7.35	1114	442	235
Univ./Hudson	3/20/2007		16.36	7.20	0.38	7.29	726	366	215
Campus St.	3/20/2007		15.34	7.82	0.84	7.41	1587	504	203
Westminister 1	3/20/2007		16.38	7.64	0.62	7.38	1185	452	216
Control	4/19/2007		18.88	4.60	0.17	7.66	341	184	134
UNI Dome PL	4/19/2007		21.80	4.19	0.21	7.65	423	239	221
Tall Grass Prairie	4/19/2007		18.62	4.47	0.30	7.61	590	297	219
UNI Towers	4/19/2007		17.36	4.72	1.03	7.41	1930	638	220
Campus St.	4/19/2007		19.69	4.99	0.23	7.55	452	242	200
Univ./Hudson	4/19/2007		19.55	4.38	0.32	7.46	630	306	217
Westminister 1	4/19/2007		14.66	5.03	0.52	7.67	998	376	251
Roth	4/19/2007		18.28	5.06	0.87	7.29	1640	548	292
Univ. Bridge E.	4/19/2007		18.97	4.60	0.25	7.44	493	255	198
Panther Lane	4/19/2007		12.65	5.49	0.22	7.67	444	214	127
Control	4/25/2007		19.43	4.12	0.16	7.93	329	147	109
Campus St.	4/25/2007	Storm	13.67	4.65	0.21	7.85	429	235	209
Univ. Bridge W.	4/25/2007	Event	11.06	4.85	0.09	7.87	197	83	70
Roth	4/25/2007		12.60	3.84	0.11	7.57	232	75	68
Westminister 1L	4/25/2007		12.50	3.90	0.14	7.53	282	93	83
Westminister 1R	4/25/2007		13.40	3.85	0.07	7.80	163	69	65
MTLP	4/25/2007		12.50	3.92	0.17	7.58	343	131	103
Univ./Hudson	4/25/2007		13.00	3.88	0.15	7.64	307	113	89
Panther Lane	4/25/2007		12.60	3.93	0.08	7.62	180	85	67

Table 5. Dry Run Creek Definitive Effluent Toxicity Test LC50's.

Site	Date	Spearman-Karber LC50
Univ. Bridge E.	5/24/2006	13.75
UNI Towers	5/24/2006	20.3125
Univ. Bridge W.	5/24/2006	43.125
UNI Towers	6/17/2006	61.875
UNI Towers	8/19/2006	4.375
Univ. Bridge E.	9/19/2006	33.75
UNI Towers	9/19/2006	10.7813
UNI Towers	10/24/2006	5.9375
Panther Lane	12/29/2006	24.375
Tall Grass Prairie	4/28/2007	3.75

Table 6. Macroinvertebrates From *In Situ* Test on Dry Run Creek.

Site	Rep	Bae	Iso	Ord	Cla	Hyd	Hem	Sim	Ort	Tan	Chi	Hep	Cae	Arg	Dub	Pet	Ste
CRB	1	76	52	16	4	1552	8	96	12	0	20	0	0	0	0	0	40
	2	88	96	16	0	1696	0	80	12	16	8	4	0	0	0	0	36
	3	128	40	32	0	1536	0	80	36	20	8	4	8	4	0	0	28
	4	232	84	40	0	1584	0	108	0	16	20	0	8	0	0	0	56
	5	72	40	12	8	616	0	4	8	12	28	0	8	0	0	0	8
UHU	1	6	8	12	0	1424	8	0	2	4	12	2	2	0	4	2	14
	2	4	4	20	0	1504	12	0	2	8	22	2	0	0	0	0	6
	3	4	0	44	0	784	2	0	0	16	18	0	0	0	0	0	6
	4	0	0	20	0	1240	4	0	0	8	10	0	0	0	0	0	18
	5	0	0	11	0	914	4	0	0	8	6	1	0	0	0	1	8
UHD	1	0	6	12	0	1032	4	0	4	12	16	0	0	0	0	0	0
	2	1	0	10	0	1128	0	0	0	8	8	0	1	0	0	0	2
	3	4	2	18	0	996	8	0	0	8	22	0	0	0	0	4	8
	4	6	2	2	0	608	6	0	4	14	6	0	0	0	0	0	0
	5	0	0	8	0	696	0	0	4	4	0	0	0	0	0	0	8
Roth	1	4	10	12	0	1296	6	0	0	16	16	2	0	0	0	0	8
	2	2	4	10	0	1232	4	0	0	8	8	0	0	2	0	0	16
	3	0	0	2	0	1584	4	0	0	18	12	2	0	0	0	4	12
	4	4	8	0	0	1080	0	0	0	20	14	4	0	0	0	6	2
	5	2	12	4	0	1352	2	0	0	10	8	4	0	0	0	2	16

Bae = Baetis
Iso = Isonychia
Ord = Ordobrevia
Cla= Claassenia
Hyd = Hydropsyche
Hem = Hemerodromia
Sim = Simulium
Ort = Orthocladiinae
Tan = Tanypodinae
Chi = Chironominae
Hep = Heptagenia
Cae = Caenis
Arg = Argia
Dub = Dubiraphia
Pet = Petrophila
Ste = Stenonema

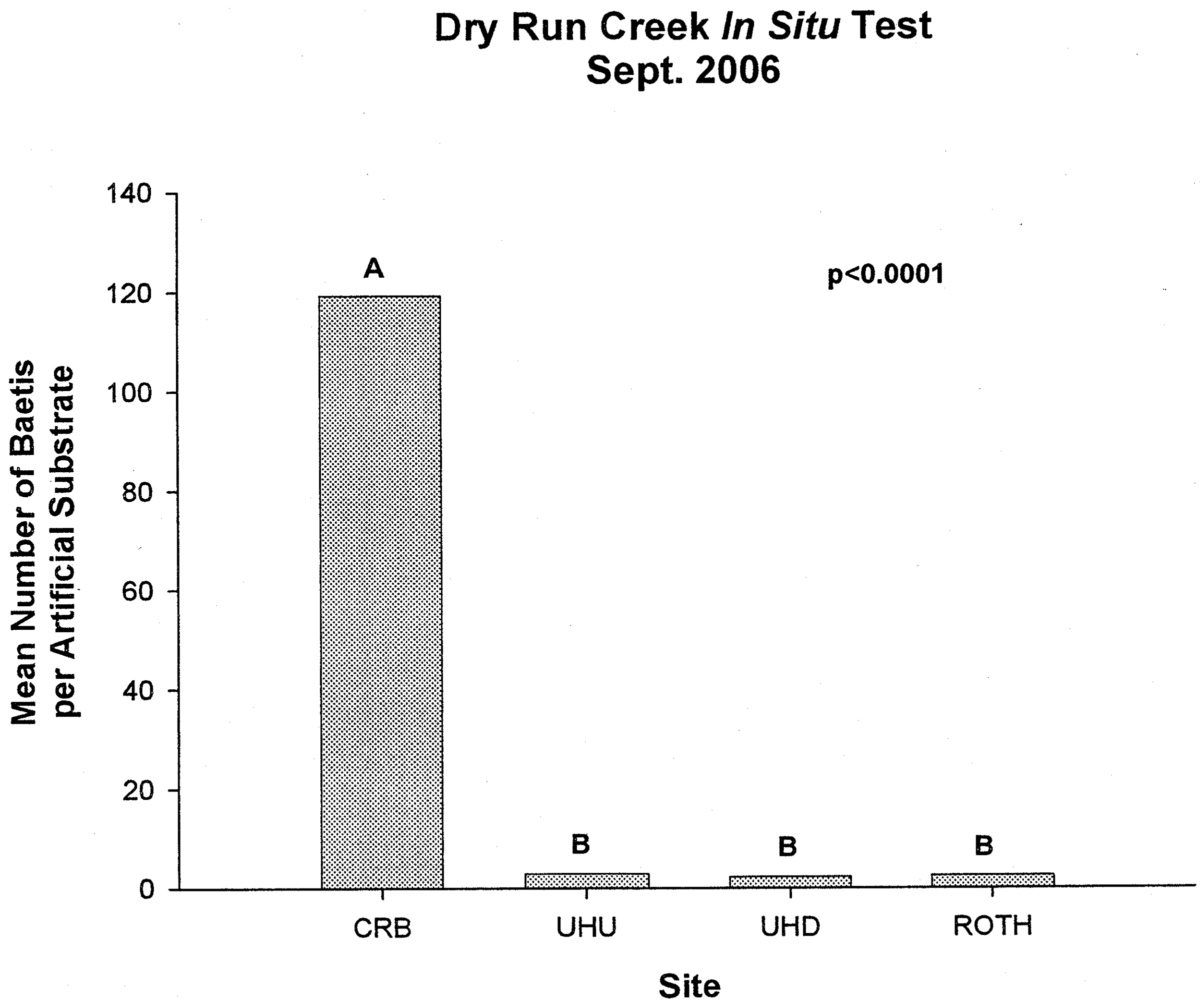

Fig. 18. Mean number of *Baetis* sp. per artificial substrate at four sites in Dry Run Creek (Iowa, USA) *in situ* test. P values are from one-way ANOVA among sites. Bars with the same letter are not significantly different (p>0.05) based on Duncan's Multiple Range Test for the separation of means.

*** CFU and CRA (Cedar River After) were unable to be sampled because of damaged caused by flooding during the seven day test.**

**** CRB = Cedar River Before**

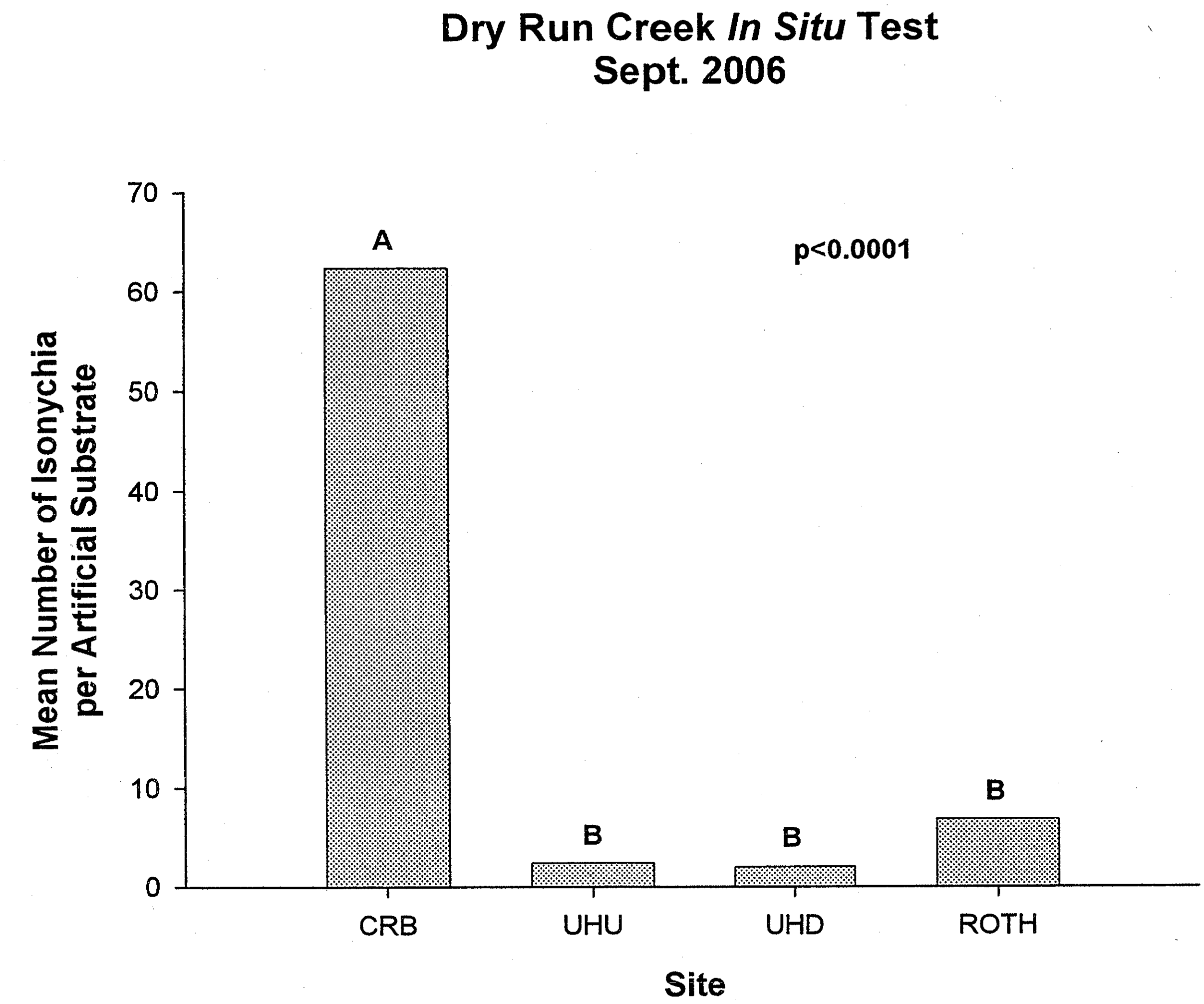

Fig. 19. Mean number of *Isonychia* sp. per artificial substrate at four sites in Dry Run Creek (Iowa, USA) *in situ* test. P values are from one-way ANOVA among sites. Bars with the same letter are not significantly different ($p>0.05$) based on Duncan's Multiple Range Test for the separation of means.

* CFU and CRA (Cedar River After) were unable to be sampled because of damaged caused by flooding during the seven day test.

** CRB = Cedar River Before

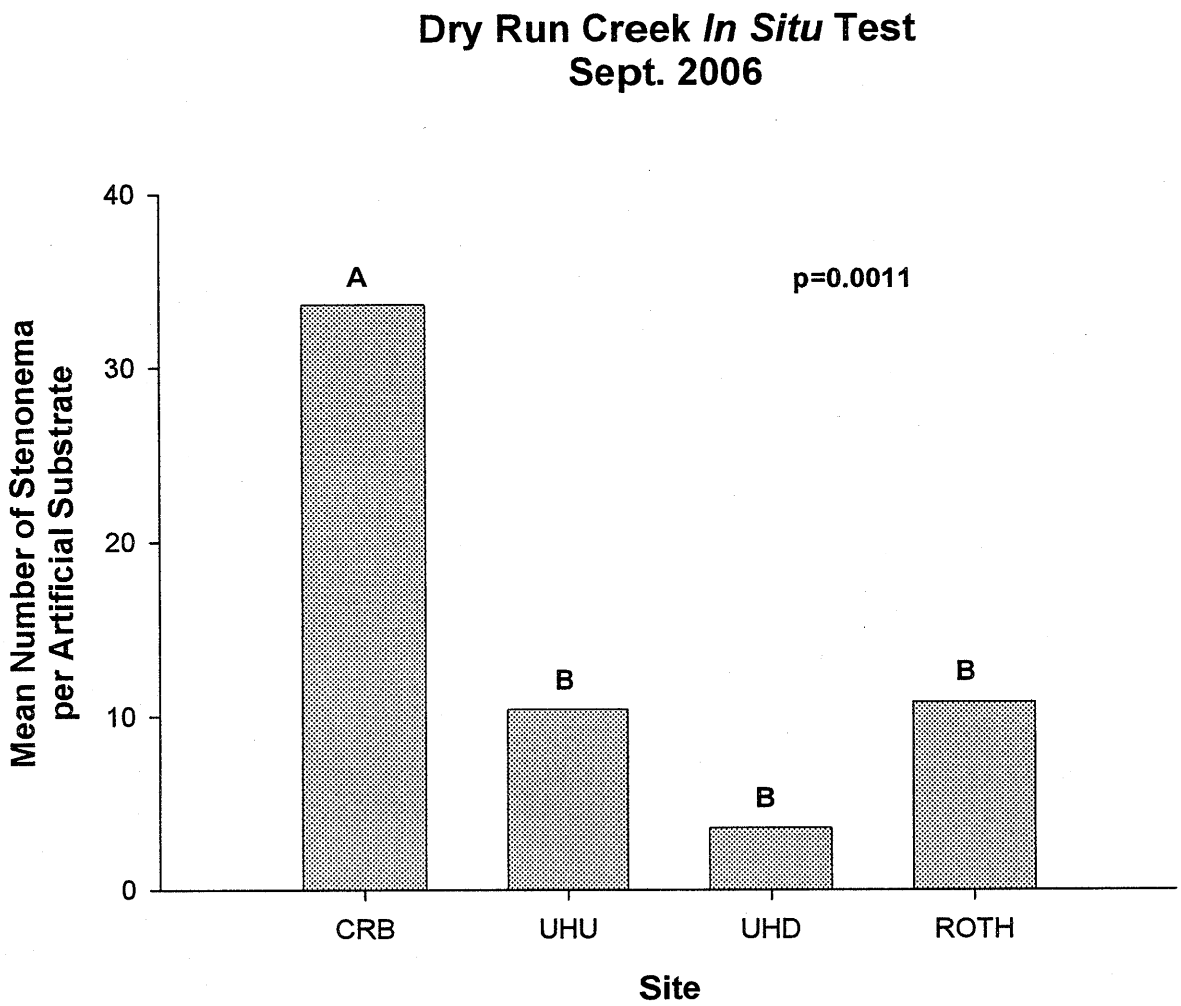

Fig. 20. Mean number of *Stenonema* sp. per artificial substrate at four sites in Dry Run Creek (Iowa, USA) *in situ* test. P values are from one-way ANOVA among sites. Bars with the same letter are not significantly different ($p>0.05$) based on Duncan's Multiple Range Test for the separation of means.

*** CFU and CRA (Cedar River After) were unable to be sampled because of damaged caused by flooding during the seven day test.**

**** CRB = Cedar River Before**

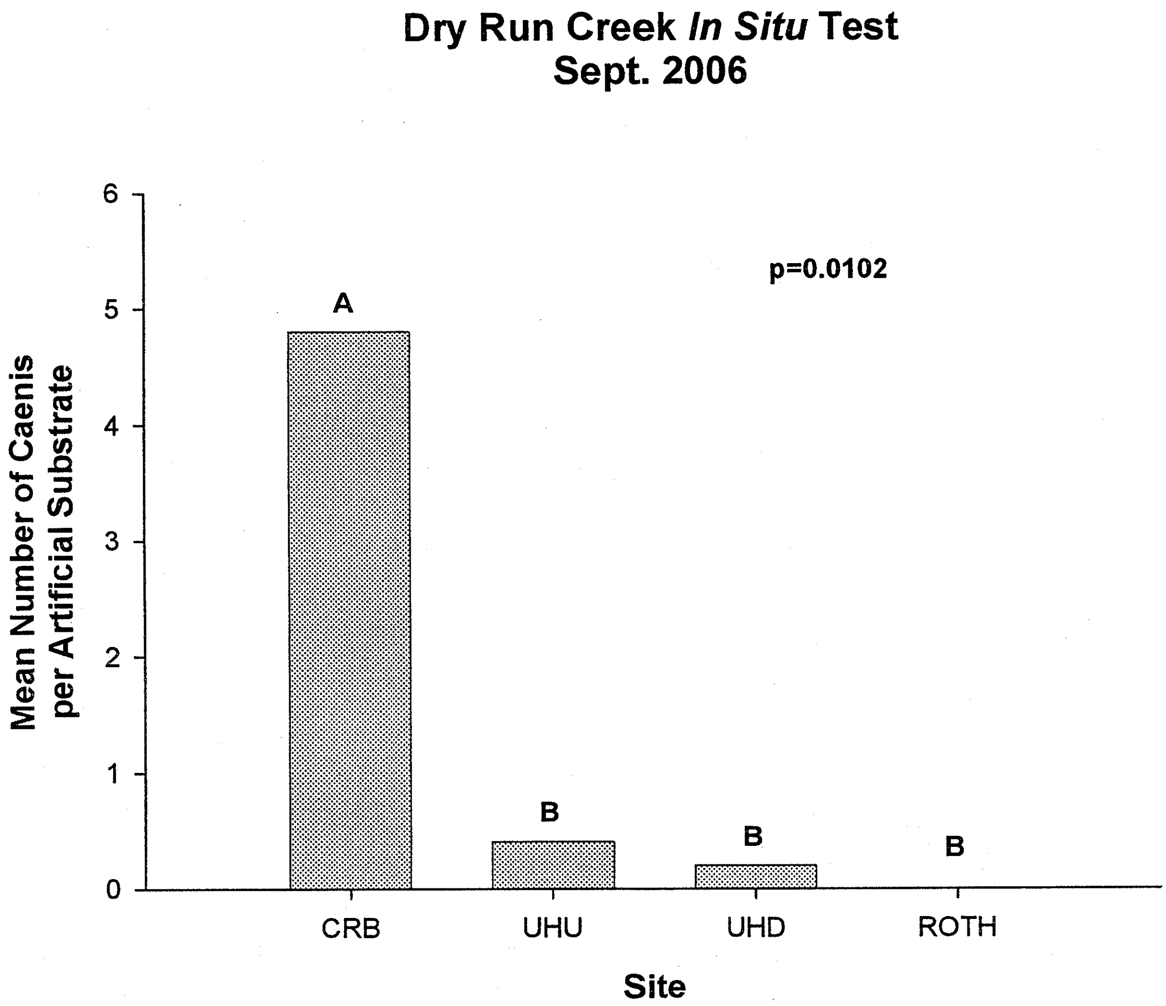

Fig. 21. Mean number of *Caenis* sp. per artificial substrate at four sites in Dry Run Creek (Iowa, USA) *in situ* test. P values are from one-way ANOVA among sites. Bars with the same letter are not significantly different (p>0.05) based on Duncan's Multiple Range Test for the separation of means.

*** CFU and CRA (Cedar River After) were unable to be sampled because of damaged caused by flooding during the seven day test.**

**** CRB = Cedar River Before**

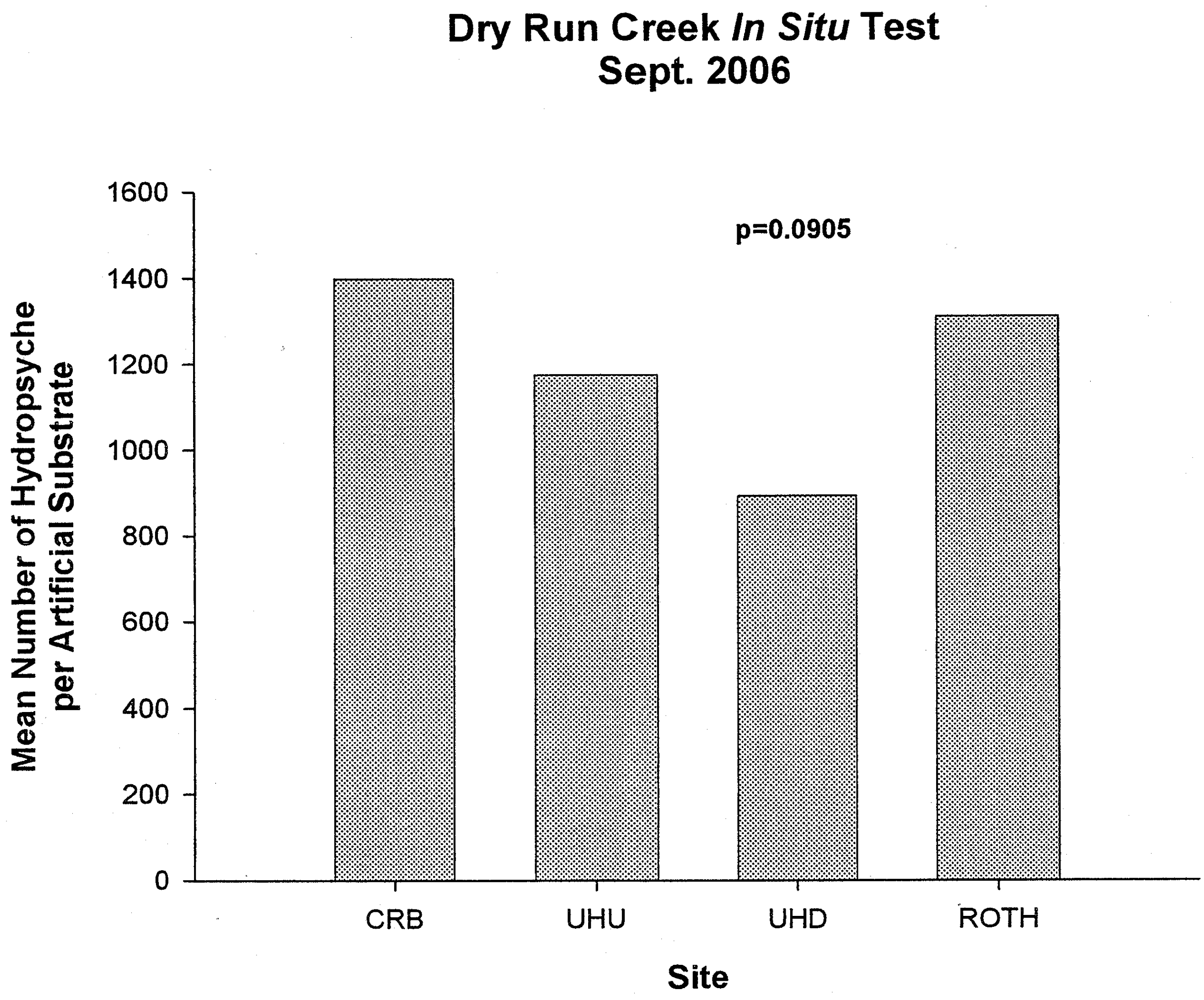

Fig. 22. Mean number of *Hydropsyche* sp. Per artificial substrate at four sites in Dry Run Creek (Iowa, USA) *in situ* test. P values are from one-way ANOVA among sites. Bars with the same letter are not significantly different (p>0.05) based on Duncan's Multiple Range Test for the separation of means.

*** CFU and CRA (Cedar River After) were unable to be sampled because of damaged caused by flooding during the seven day test.**

**** CRB = Cedar River Before**

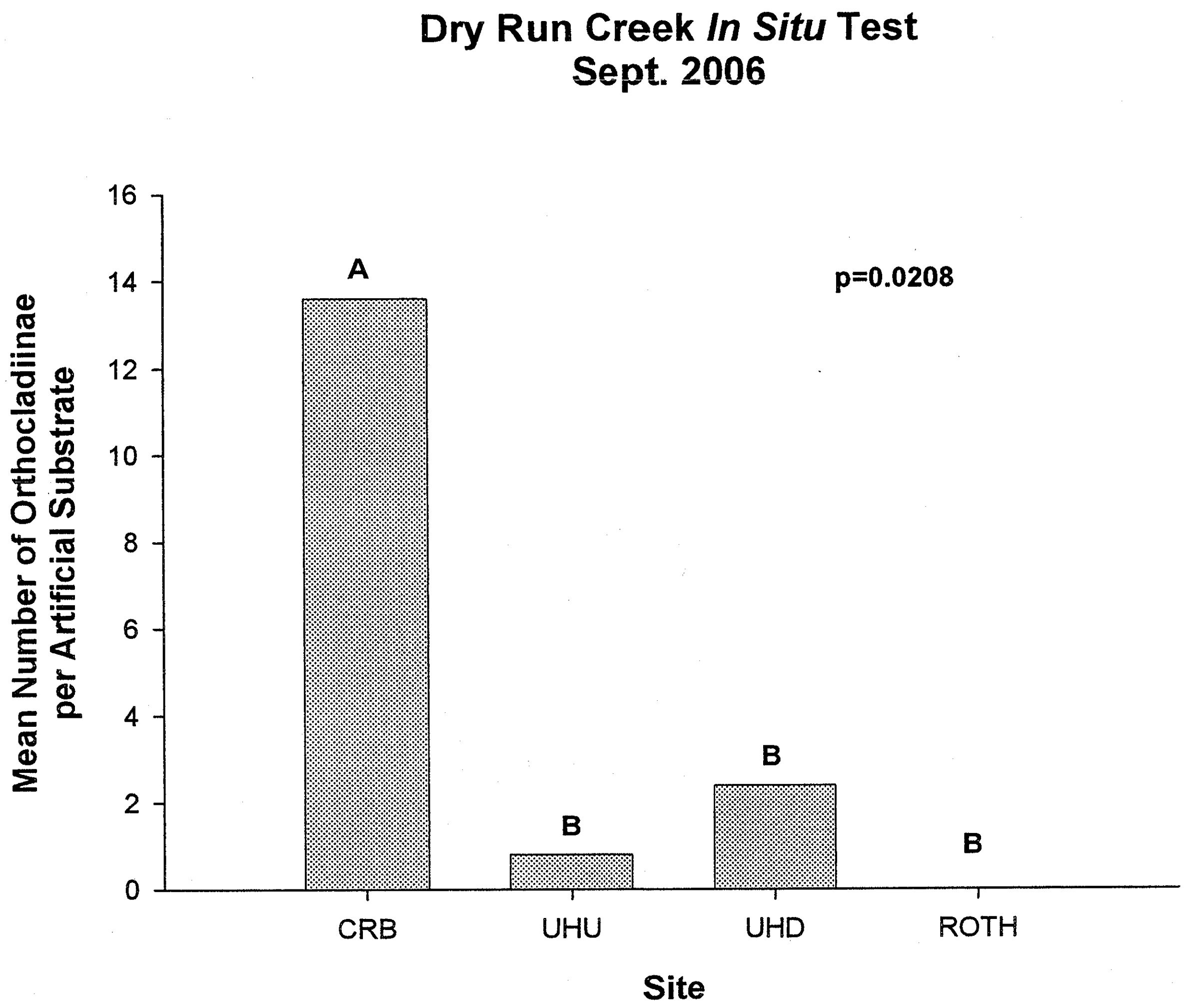

Fig. 23. Mean number of Orthocladiinae per artificial substrate at four sites in Dry Run Creek (Iowa, USA) *in situ* test. P values are from one-way ANOVA among sites. Bars with the same letter are not significantly different (p>0.05) based on Duncan's Multiple Range Test for the separation of means.

*** CFU and CRA (Cedar River After) were unable to be sampled because of damaged caused by flooding during the seven day test.**

**** CRB = Cedar River Before**

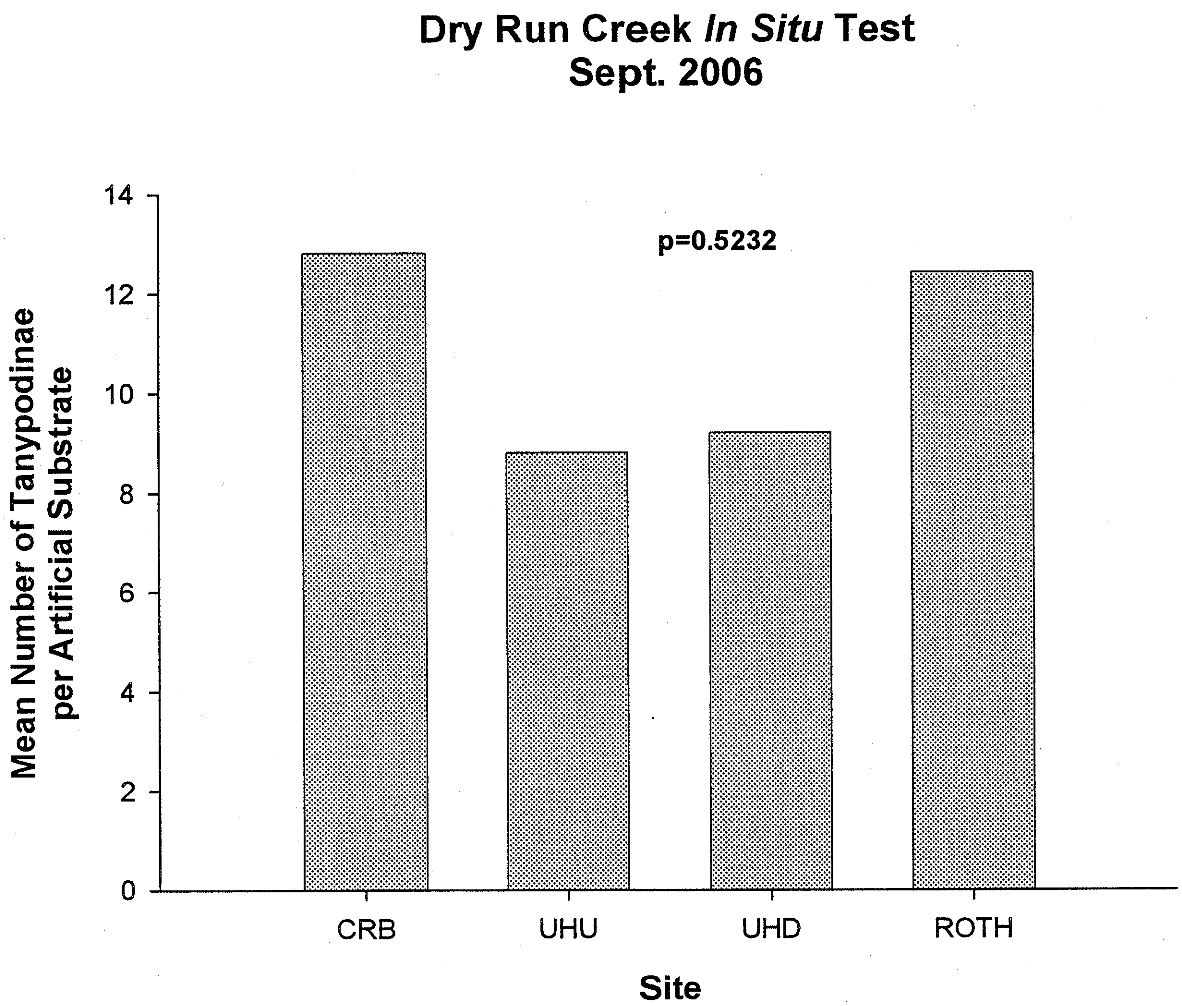

Fig. 24. Mean number of Tanypodinae per artificial substrate at four sites in Dry Run Creek (Iowa, USA) *in situ* test. P values are from one-way ANOVA among sites. Bars with the same letter are not significantly different (p>0.05) based on Duncan's Multiple Range Test for the separation of means.

*** CFU and CRA (Cedar River After) were unable to be sampled because of damaged caused by flooding during the seven day test.**

**** Cedar River Before**

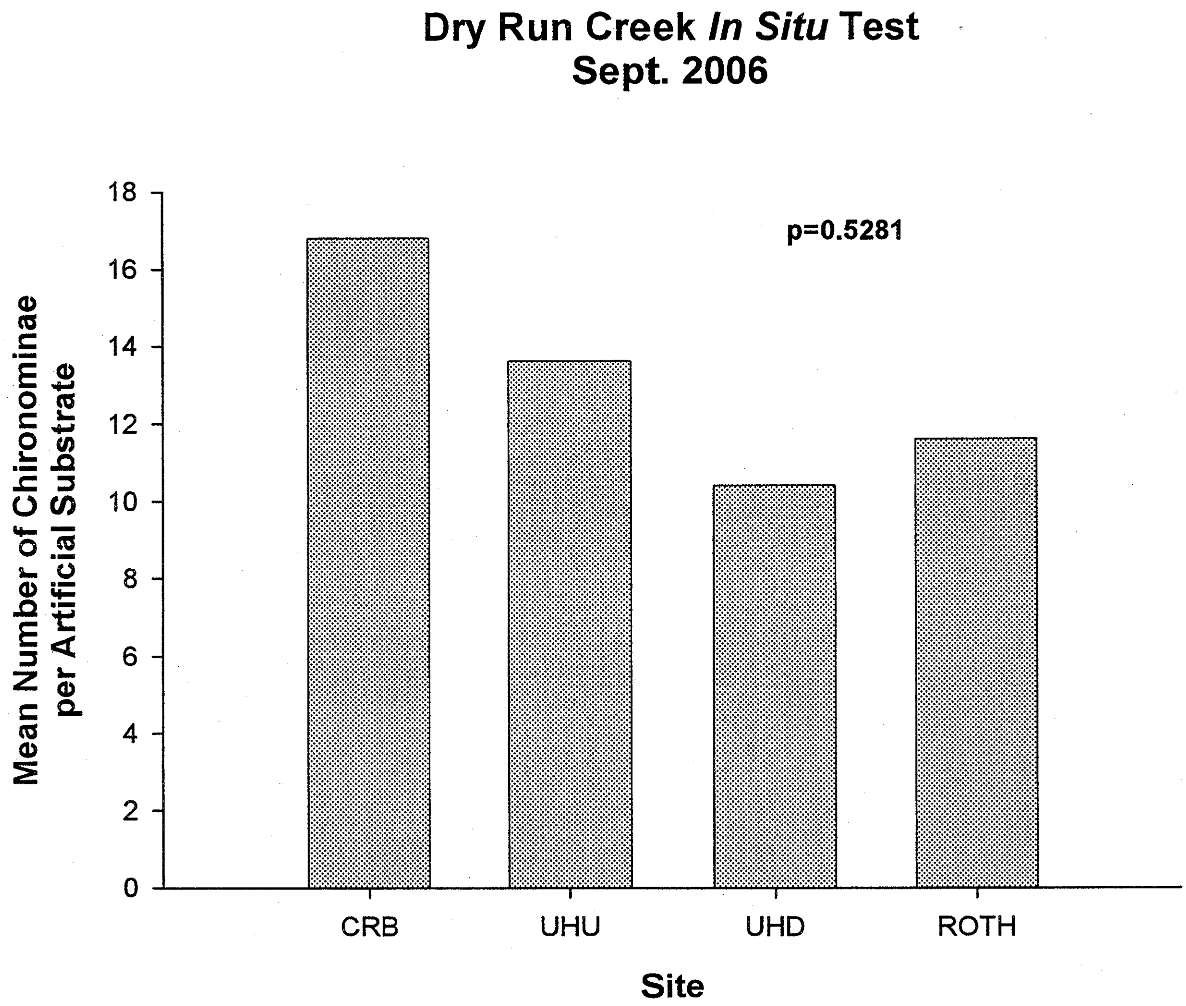

Fig. 25. Mean number of Chironominae per artificial substrate at four sites in Dry Run Creek (Iowa, USA) *in situ* test. P values are from one-way ANOVA among sites. Bars with the same letter are not significantly different (p>0.05) based on Duncan's Multiple Range Test for the separation of means.

*** CFU and CRA (Cedar River After) were unable to be sampled because of damaged caused by flooding during the seven day test.**

**** CRB = Cedar River Before**

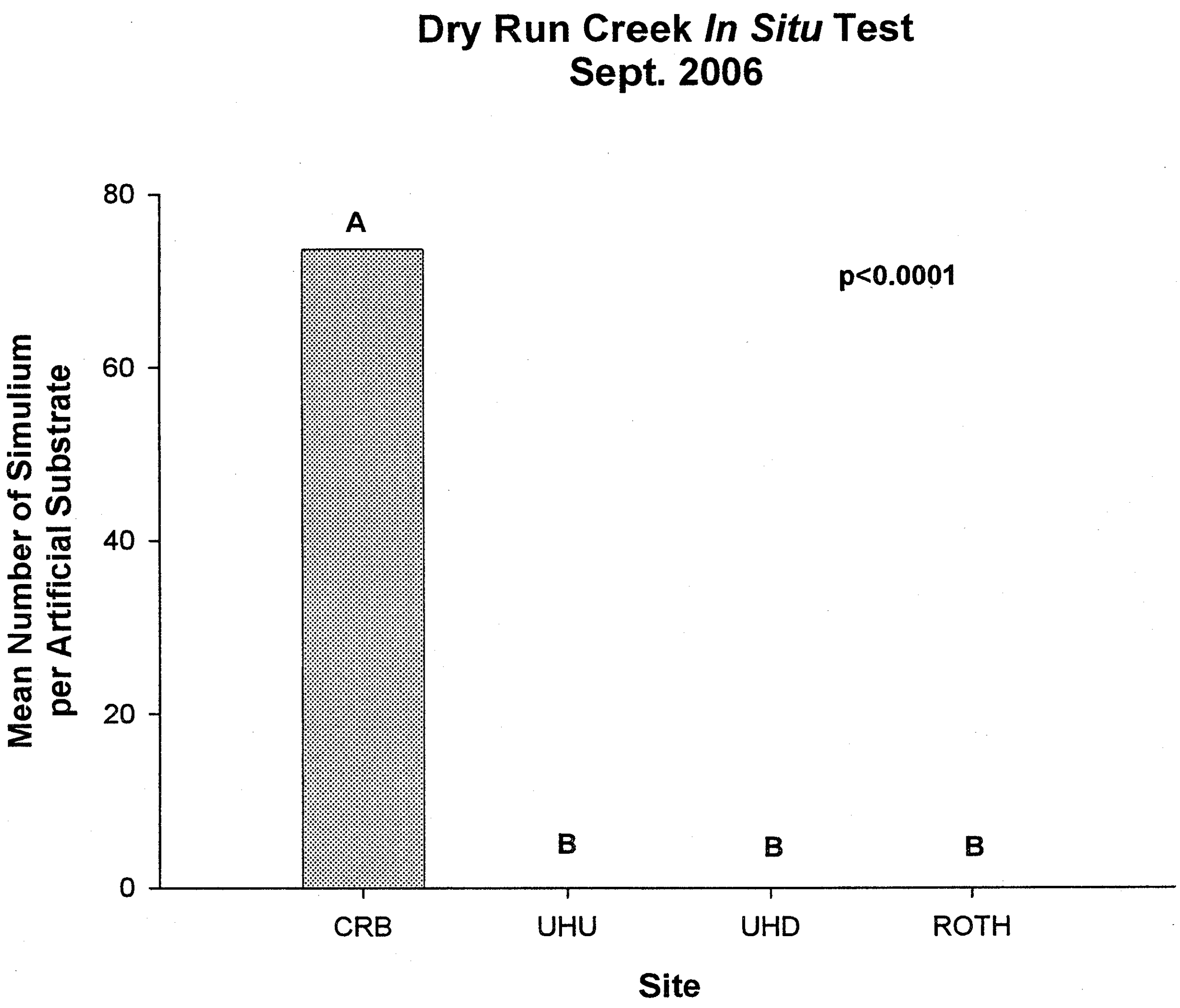

Fig. 26. Mean number of *Simulium* sp. per artificial substrate at four sites in Dry Run Creek (Iowa, USA) *in situ* test. P values are from one-way ANOVA among sites. Bars with the same letter are not significantly different (p>0.05) based on Duncan's Multiple Range Test for the separation of means.

*** CFU and CRA (Cedar River After) were unable to be sampled because of damaged caused by flooding during the seven day test.**

**** CRB = Cedar River Before**

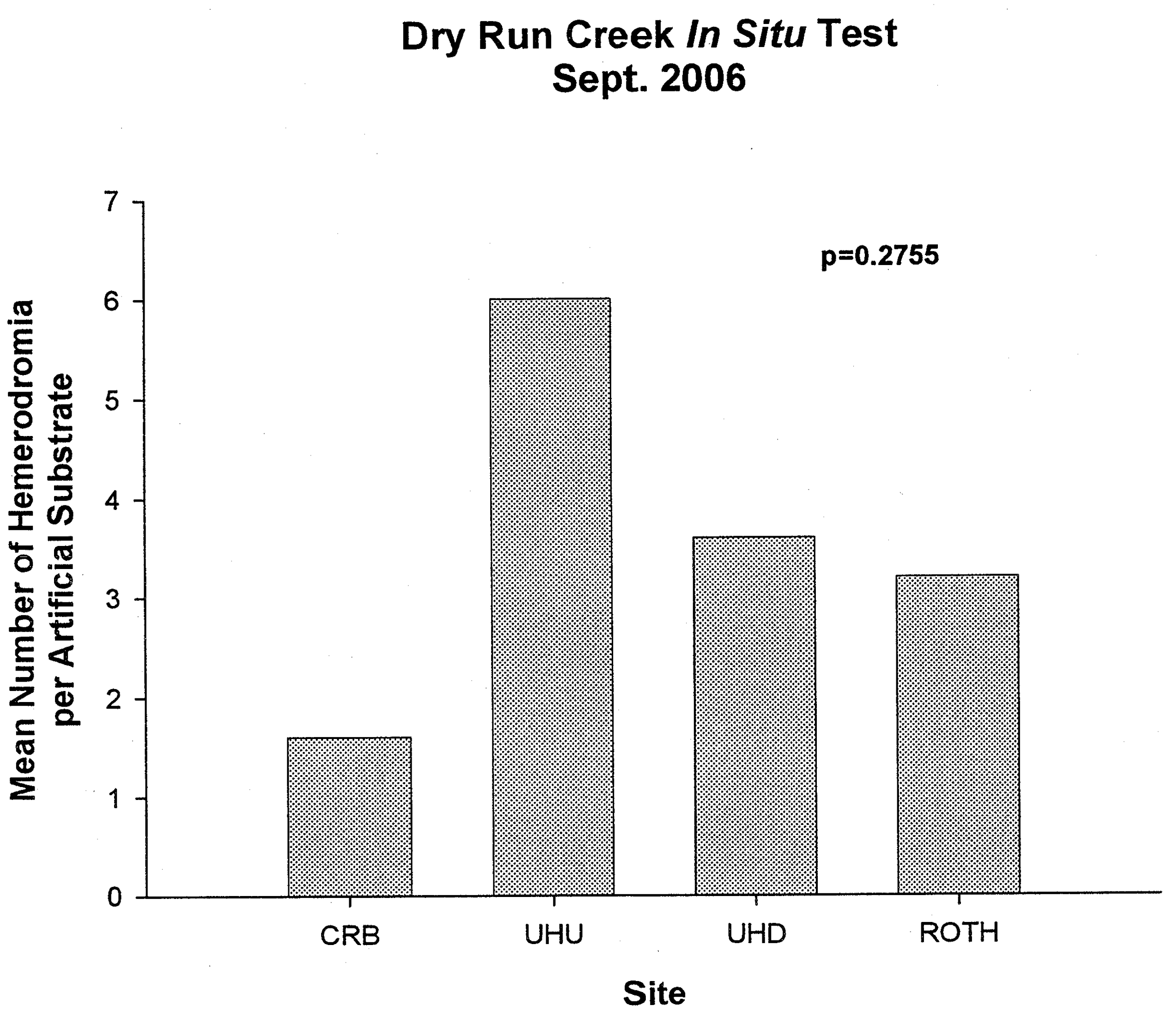

Fig. 27. Mean number of *Hemerodromia* sp. per artificial substrate at four sites in Dry Run Creek (Iowa, USA) *in situ* test. P values are from one-way ANOVA among sites. Bars with the same letter are not significantly different (p>0.05) based on Duncan's Multiple Range Test for the separation of means.

*** CFU and CRA (Cedar River After) were unable to be sampled because of damaged caused by flooding during the seven day test.**

**** CRB = Cedar River Before**

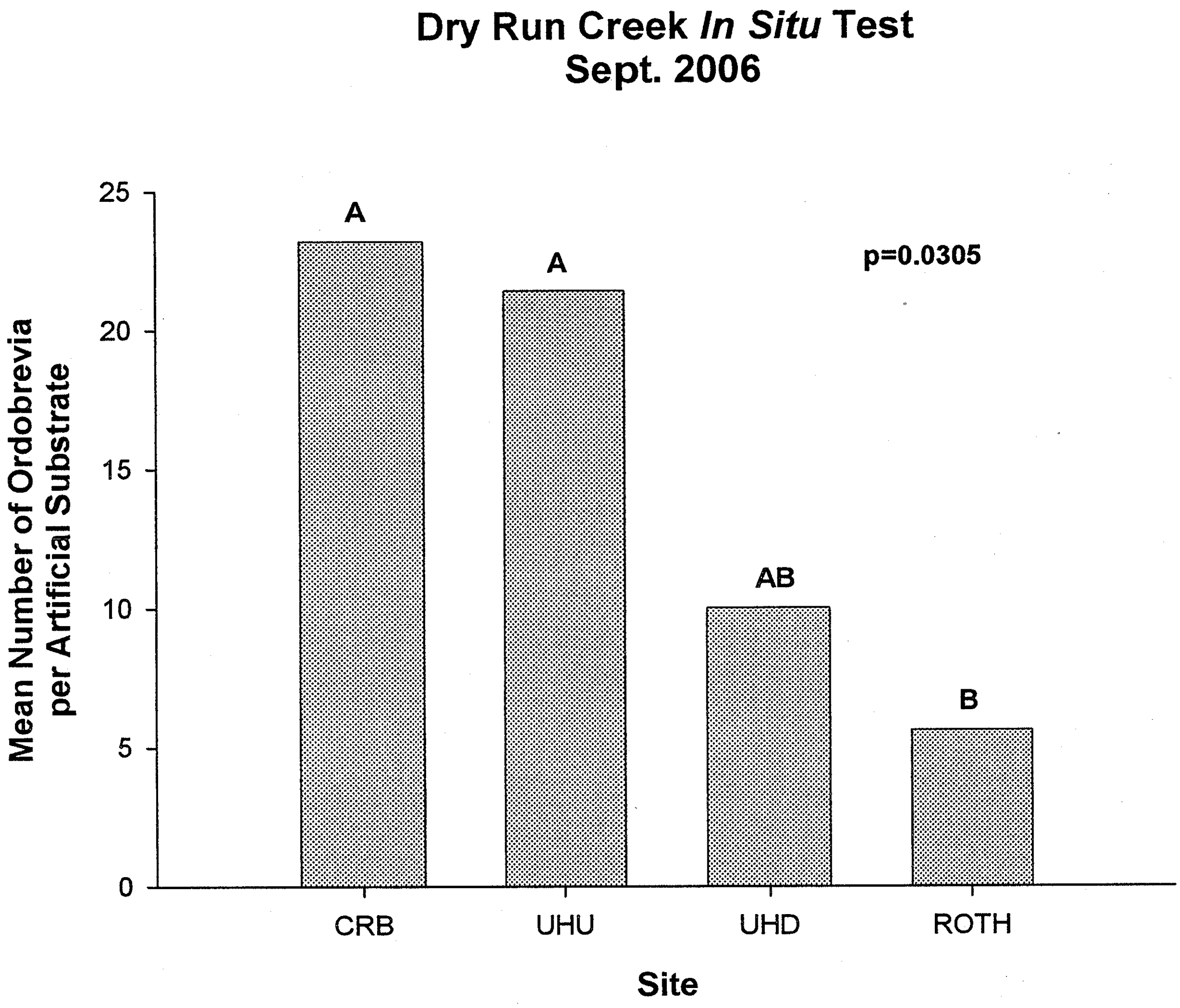

Fig. 28. Mean number of *Ordobrevia* sp. per artificial substrate at four sites in Dry Run Creek (Iowa, USA) *in situ* test. P values are from one-way ANOVA among sites. Bars with the same letter are not significantly different (p>0.05) based on Duncan's Multiple Range Test for the separation of means.

*** CFU and CRA (Cedar River After) were unable to be sampled because of damaged caused by flooding during the seven day test.**

**** CRB = Cedar River Before**

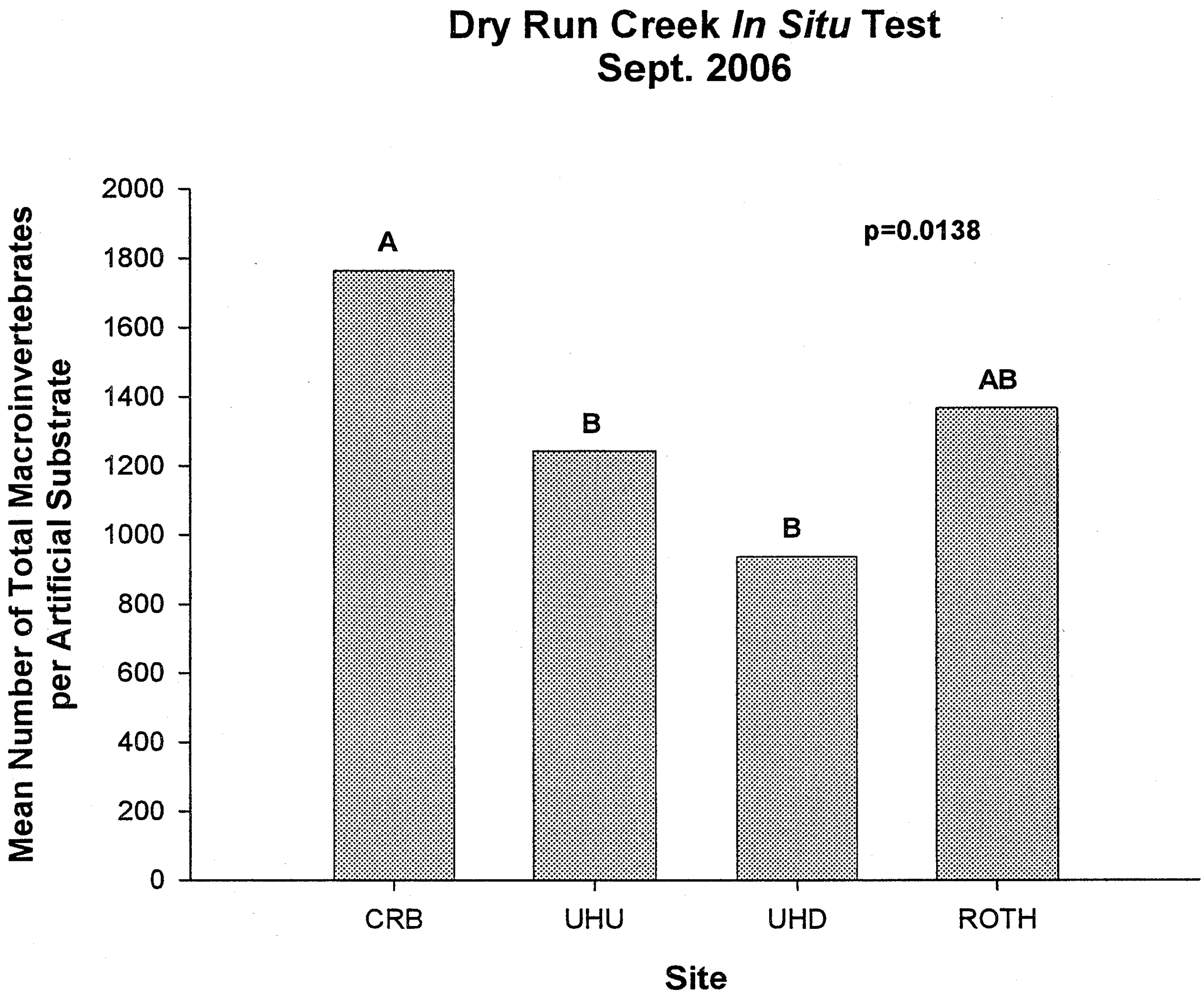

Fig. 29. Mean number of total macroinvertebrates per artificial substrate at four sites in Dry Run Creek (Iowa, USA) *in situ* test. P values are from one-way ANOVA among sites. Bars with the same letter are not significantly different (p>0.05) based on Duncan's Multiple Range Test for the separation of means.

*** CFU and CRA (Cedar River After) were unable to be sampled because of damaged caused by flooding during the seven day test.**

**** CRB = Cedar River Before**

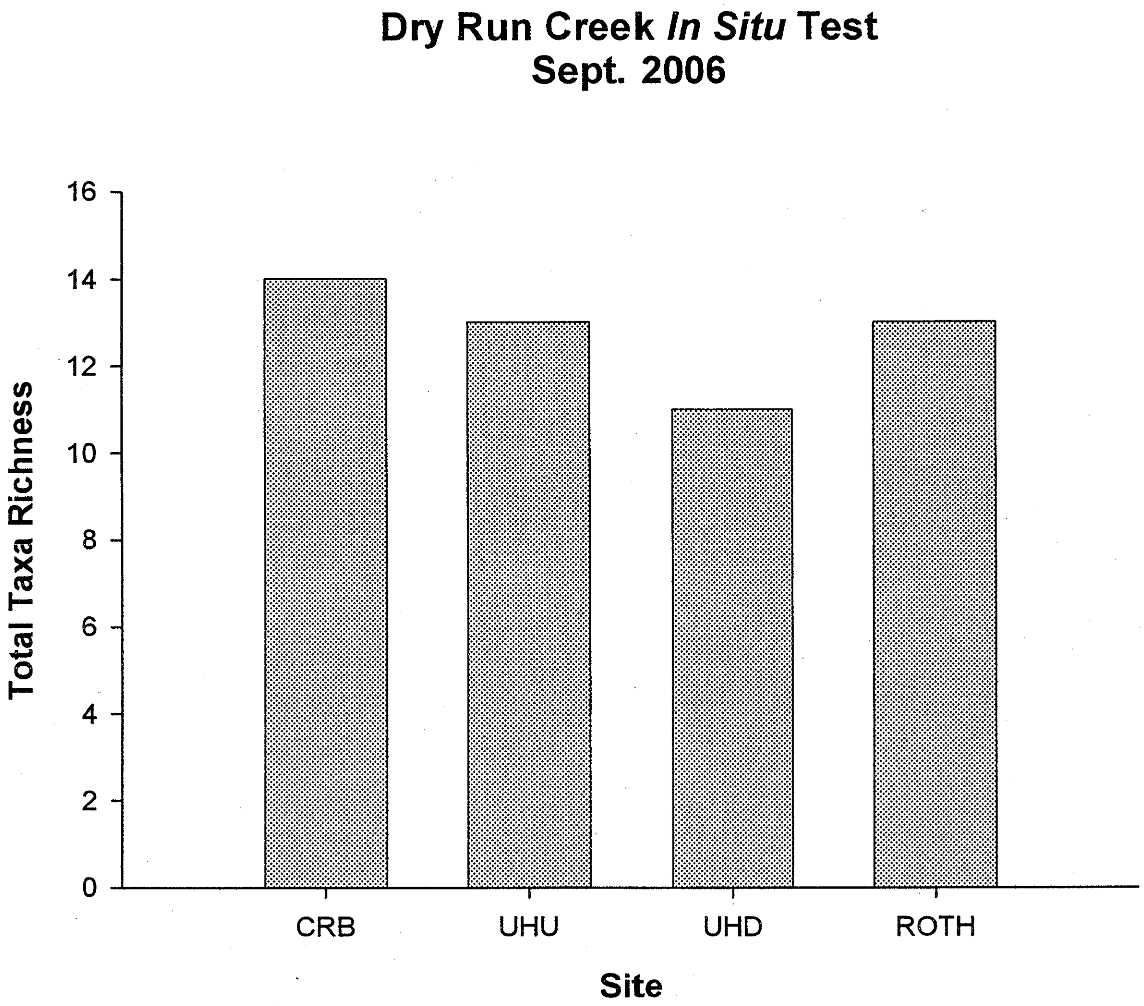

Fig. 30. Total taxa richness found at each site during the *in situ* test in Dry Run Creek (Iowa, USA).

*** CRA (Cedar River After) and CFU were not able to be sampled because of damage to the artificial substrates.**

**** CRB = Cedar River Before**

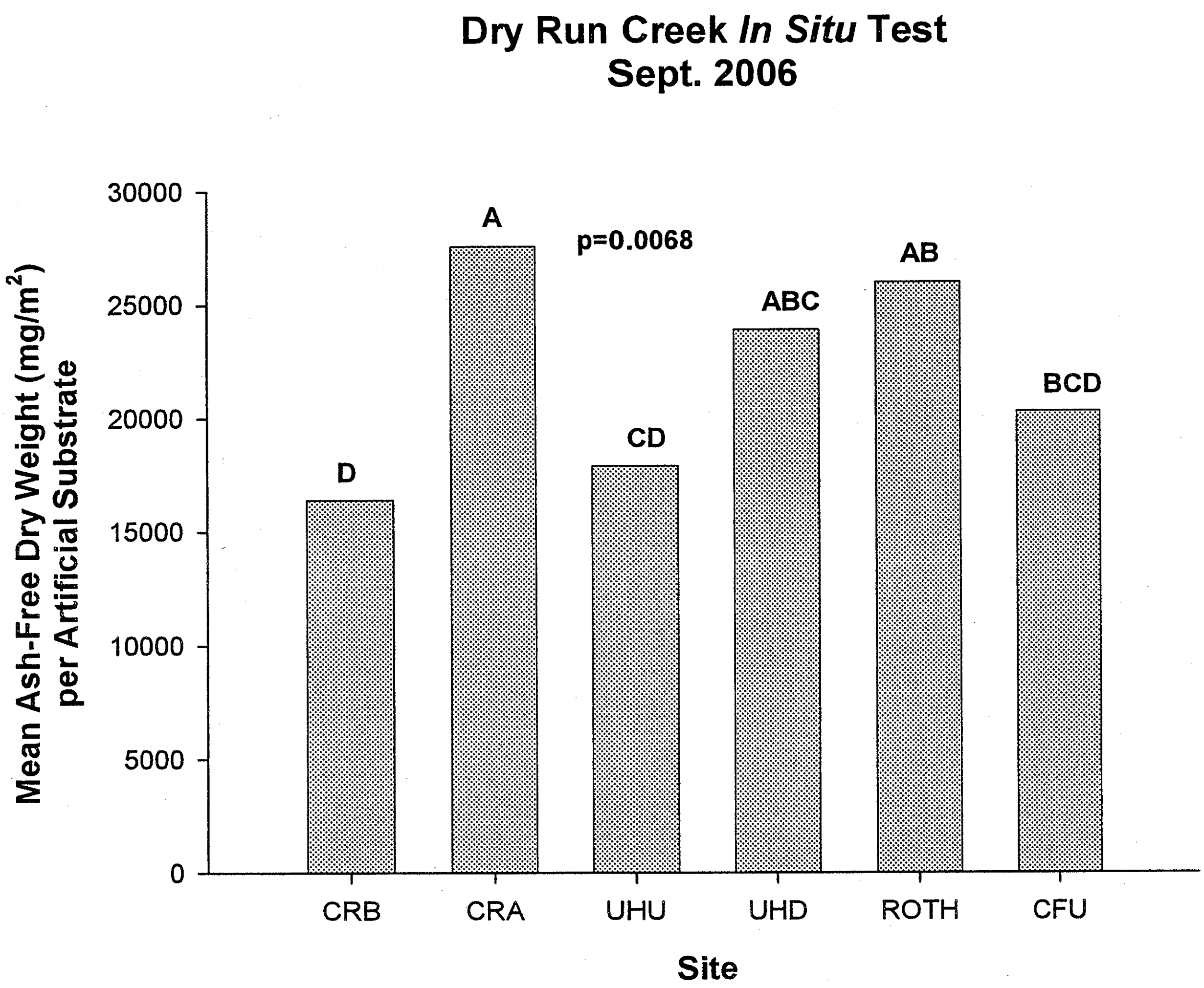

Fig. 31. Mean ash-free dry weight (mg/m^2) per artificial substrate at six sites in Dry Run Creek (Iowa, USA) *in situ* test. P values are from one-way ANOVA among sites. Bars with the same letter are not significantly different ($p>0.05$) based on Duncan's Multiple Range Test for the separation of means.

*** CRB = Cedar River Before**
*** CRA = Cedar River After**

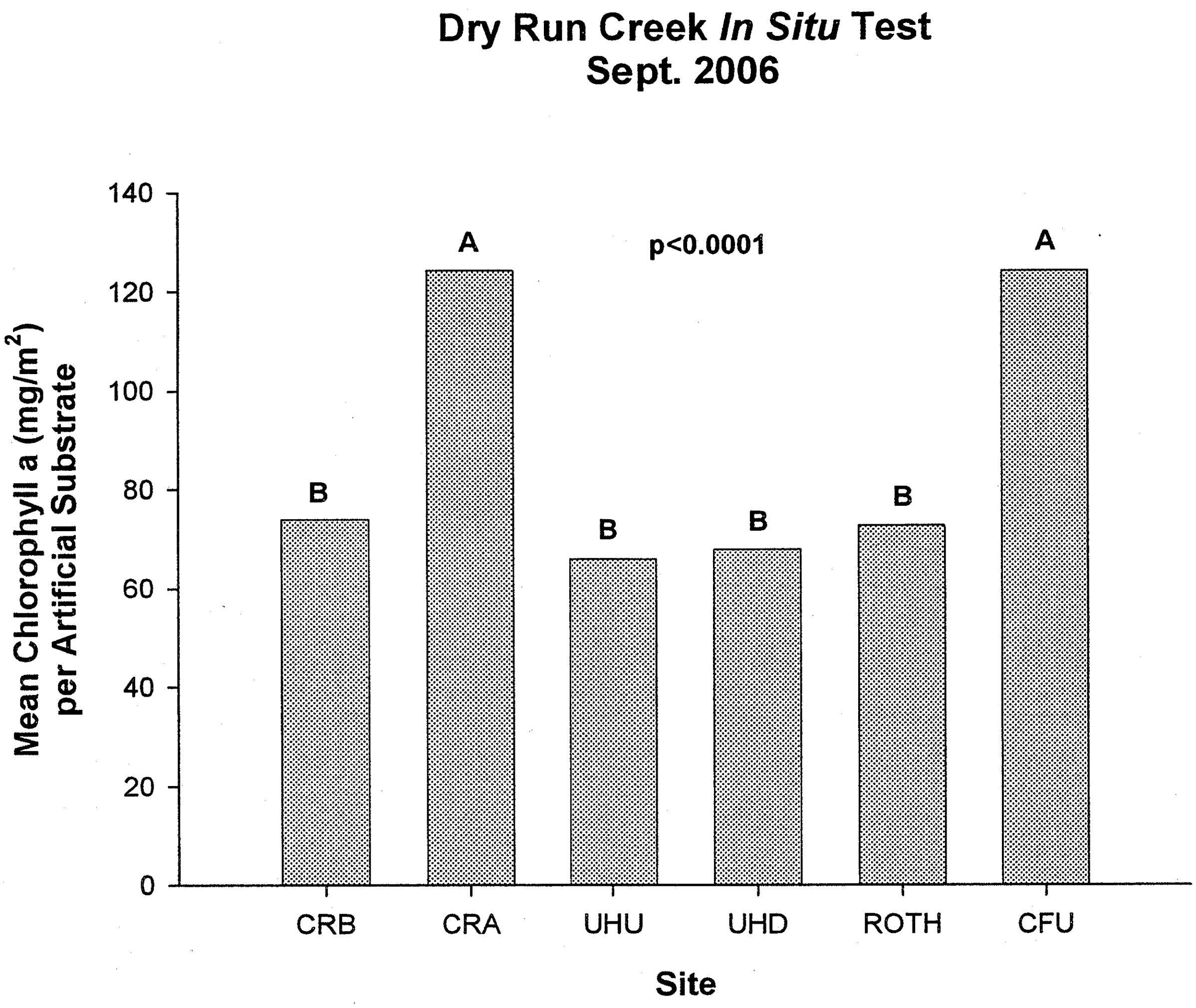

Fig. 32. Mean chlorophyll a (mg/m²) per artificial substrate at six sites in Dry Run Creek (Iowa, USA) *in situ* test. P values are from one-way ANOVA among sites. Bars with the same letter are not significantly different (p>0.05) based on Duncan's Multiple Range Test for the separation of means.

*** CRB = Cedar River Before**
*** CRA = Cedar River After**

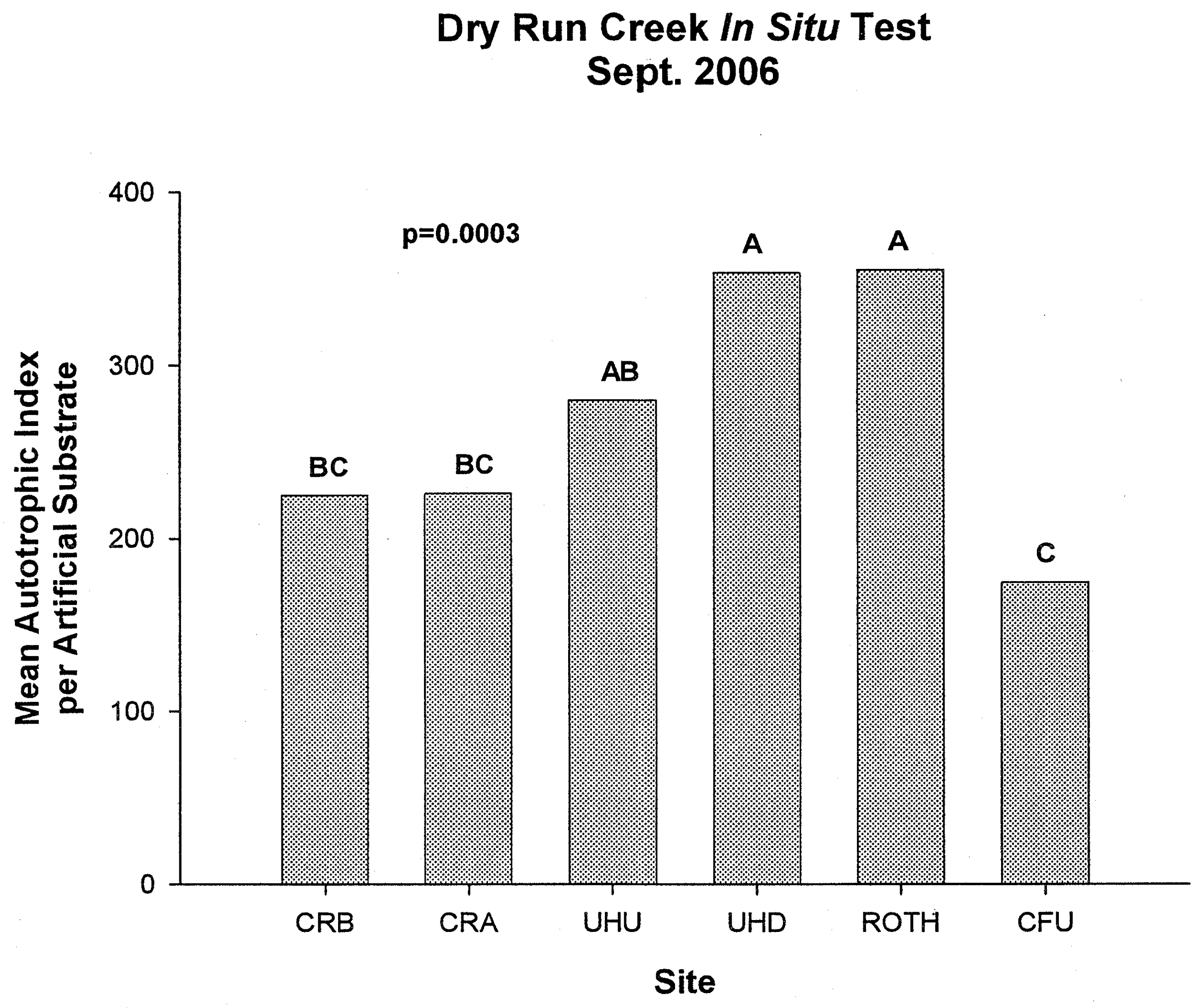

Fig. 33. Mean Autotrophic Index per artificial substrate at six sites in Dry Run Creek (Iowa, USA) *in situ* test. P values are from one-way ANOVA among sites. Bars with the same letter are not significantly different (p>0.05) based on Duncan's Multiple Range Test for the separation of means.

*** CRB = Cedar River Before**
*** CRA = Cedar River After**

Appendix A. List of all taxa identified in the Dry Run Creek Ecotoxicological Evaluation.

Insecta
- **Ephemeroptera**
  - **Caenidae**
    - ***Caenis* sp.**
  - **Baetidae**
    - ***Baetis* sp.**
  - **Heptagenidae**
    - ***Heptagenia* sp.**
    - ***Stenacron* sp.**
    - ***Stenonema* sp.**
  - **Isonychiidae**
    - ***Isonychia* sp.**
  - **Leptophlebiidae**
    - ***Leptophlebia* sp.**
- **Trichoptera**
  - **Brachycentridae**
    - ***Brachycentrus* sp.**
  - **Hydropsychidae**
    - ***Hydropsyche* sp.**
  - **Hydroptilidae**
    - ***Ochrotrichia* sp.**
- **Coleoptera**
  - **Elmidae**
    - ***Stenelmis* sp.**
    - ***Ordobrevia* sp.**
    - ***Dubiraphia* sp.**
    - ***Lara* sp.**
  - **Dytiscidae**
    - ***Agabinus* sp.**
    - ***Ilybius* sp.**
  - **Hydrophilidae**
    - ***Tropisternus* sp.**
- **Diptera**
  - **Chironomidae**
    - **Tanypodinae**
    - **Orthocladiinae**
    - **Chironominae**

Appendix A. (Continued) List of all taxa identified in the Dry Run Creek Ecotoxicological Evaluation.

- Simuliidae
  - *Simulium* sp.
- Empididae
  - *Hemerodromia* sp.
- Athericidae
  - *Antherix* sp.
- Tipulidae
  - *Tipula* sp.
  - *Hexatoma* sp.
- Ceratopogonidae
  - *Probezzia* sp.

Plecoptera
- Perlidae
  - *Claassenia* sp.
- Taeniopterygidae
  - *Taeniopteryx* sp.

Lepidoptera
- Pyralidae
  - *Petrophila* sp.

Megaloptera
- Corydalidae
  - *Corydalus* sp.

Odonata
- Aeshnidae
- Calopterygidae
  - *Calopteryx* sp.
- Coenagrionidae
  - *Argia* sp.

Crustacea
- Amphipoda
  - *Gammarus* sp.
  - *Hyalella* sp.

Appendix B. Macroinvertebrates Collected From Sample Sites on Dry Run Creek

Site	Mon	Rep	Ste	Hya	Gam	Hyd	Sim	Stc	Hem	Cal	Arg	Tro	Hex	Aes	Bae	Hep	Aga	Cla	Dub	Ort	Tan	Chi	Pro	Tip	Ord	Cae	Bra	Ocl	Lep	Iso	Lar	Tae	Ily
Roth	May	1	0	0	0	16	11	0	0	0	0	0	0	0	4	1	0	0	0	19	5	1	0	0	0	0	0	0	0	0	0	0	0
	May	2	0	0	0	24	6	0	0	0	0	0	0	0	2	0	0	0	0	17	3	1	0	0	0	0	0	0	0	0	0	0	0
	May	3	0	0	0	19	4	0	0	0	0	0	0	0	0	0	0	0	0	12	5	1	0	0	0	0	0	0	0	0	0	0	0
	May	4	0	0	0	18	6	0	0	0	0	0	0	0	4	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0
UHU	May	1	0	0	0	84	14	0	0	0	0	0	1	0	5	2	0	8	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0
	May	2	0	0	0	112	2	0	0	0	0	0	0	0	3	2	0	8	0	0	0	7	0	1	0	0	0	0	0	0	0	0	0
	May	3	0	0	0	140	2	0	0	0	0	2	0	1	6	3	0	11	0	0	0	29	0	0	0	0	0	0	0	0	0	0	0
	May	4	3	0	0	103	2	0	0	0	0	0	0	0	2	2	1	8	0	11	6	5	0	0	0	2	0	0	0	0	0	0	0
UHD	May	1	0	0	0	99	12	0	0	0	0	0	0	0	5	2	0	4	0	21	3	0	0	0	0	0	0	0	0	0	0	0	0
	May	2	0	0	0	121	52	0	0	0	0	0	0	0	4	5	1	7	0	19	2	1	0	0	0	0	0	0	0	0	0	0	0
	May	3	1	0	0	73	5	0	0	0	1	0	0	0	4	5	0	7	0	29	2	0	0	0	0	4	0	0	0	0	0	0	0
	May	4	0	0	0	41	3	0	0	0	0	0	0	0	8	4	1	3	0	11	3	0	1	0	0	0	0	0	0	0	0	0	0
Roth	June	1	0	0	0	112	15	0	0	0	0	0	0	0	0	0	0	0	0	6	5	0	0	1	0	0	0	0	0	0	0	0	0
	June	2	0	0	0	105	20	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	June	3	0	0	0	77	10	0	0	0	0	0	0	0	0	0	0	0	0	3	2	0	0	0	0	0	0	0	0	0	0	0	0
	June	4	0	2	0	88	23	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0
UHU	June	1	0	2	0	41	1	0	0	0	0	0	0	0	2	4	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	June	2	1	0	0	58	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	June	3	1	4	0	39	1	8	0	0	0	0	0	0	1	3	0	0	0	4	3	1	0	0	0	0	0	0	0	0	0	0	0
	June	4	0	2	2	18	0	11	0	0	0	0	0	0	2	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
UHD	June	1	0	0	0	170	16	1	1	0	0	0	0	0	18	4	0	1	0	15	3	2	0	0	0	0	0	0	0	0	0	0	0
	June	2	0	0	0	234	2	1	1	0	1	0	0	0	5	4	0	4	0	16	3	0	0	0	0	0	0	0	0	0	0	0	0
	June	3	0	0	1	62	3	2	0	0	0	0	0	0	18	4	0	0	0	5	3	0	0	0	1	0	0	0	0	0	0	0	0
	June	4	0	0	0	138	0	0	0	0	0	0	0	0	3	2	0	2	0	9	0	0	0	0	3	0	0	0	0	0	0	0	0
CFU	June	1	0	0	0	73	12	0	0	0	0	0	0	0	15	0	0	0	0	4	3	0	0	1	0	0	0	0	0	0	0	0	0
	June	2	0	0	0	116	40	0	1	0	0	0	0	0	70	0	0	0	0	4	2	1	0	1	0	0	0	0	0	0	0	0	0
	June	3	0	0	0	87	24	0	0	0	0	0	0	0	43	0	0	0	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0
	June	4	0	1	0	64	42	0	0	0	0	0	0	0	37	0	0	0	0	3	2	0	0	0	0	0	0	0	0	0	0	0	0
Roth	July	1	0	1	0	43	43	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
	July	2	0	0	0	17	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Apppendix B Continued. Mascroinvertebrates Collected From Sample Sites on Dry Run Creek.

Site	Mon	Rep	Ste	Hya	Gam	Hyd	Sim	Stc	Hem	Cal	Arg	Tro	Hex	Aes	Bae	Hep	Aga	Cla	Dub	Ort	Tan	Chi	Pro	Tip	Ord	Cae	Bra	Och	Lep	Iso	Lar	Tae	Ily
	July	3	0	0	0	19	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	July	4	0	0	0	46	18	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UHU	July	1	0	0	0	33	0	29	0	7	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0
	July	2	0	0	0	12	0	23	1	4	0	0	0	0	1	0	0	0	0	1	1	4	0	0	2	0	0	0	0	0	0	0	0
	July	3	0	0	0	9	1	31	0	4	0	0	0	0	1	0	0	0	0	0	6	1	0	0	1	0	0	0	0	0	0	0	0
	July	4	0	0	0	20	0	18	0	4	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0
UHD	July	1	0	0	0	142	2	14	0	0	1	0	0	0	8	0	0	0	0	0	3	0	0	0	0	1	0	0	0	0	0	0	0
	July	2	0	0	0	130	5	8	1	0	1	0	0	0	13	2	0	0	0	4	0	2	0	0	2	1	0	0	0	0	0	0	0
	July	3	1	0	0	172	9	14	2	0	5	0	0	0	5	1	0	0	0	4	1	0	0	0	0	1	0	0	0	0	0	0	0
	July	4	0	0	1	143	9	9	0	0	1	0	0	0	2	0	0	0	0	5	4	0	0	0	0	0	0	0	0	0	0	0	0
CFU	July	1	1	0	0	58	38	0	2	0	0	0	0	0	23	0	0	0	0	5	2	0	0	0	0	0	0	0	0	0	0	0	0
	July	2	0	0	0	75	13	0	3	0	0	0	0	0	49	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	July	3	0	0	0	164	89	0	0	0	0	0	0	0	52	0	0	0	0	2	8	0	0	0	0	0	0	0	0	0	0	0	0
	July	4	0	0	0	129	40	0	0	0	0	0	0	0	73	0	0	0	0	7	3	0	0	0	0	0	0	0	0	0	0	0	0
Roth	Aug	1	0	0	0	28	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
	Aug	2	0	1	0	38	1	0	1	0	0	0	0	0	0	0	0	0	1	1	2	0	0	1	0	0	0	0	0	0	0	0	0
	Aug	3	0	5	0	46	2	0	0	0	0	0	0	0	0	0	0	0	0	1	6	0	0	1	0	0	1	0	0	0	0	0	0
	Aug	4	0	2	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
UHU	Aug	1	4	0	0	8	0	3	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	1	1	0	0	0	0	0	0	0
	Aug	2	0	0	1	4	1	3	0	0	0	0	0	0	0	0	0	0	2	1	0	1	0	0	0	0	0	0	0	0	0	0	0
	Aug	3	0	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	1	0	0	0	0	0	0	0
	Aug	4	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	3	1	0	13	0	0	0	1	0	0	0	0	0	0	0
UHD	Aug	1	0	1	0	7	0	0	0	0	4	0	0	0	0	0	0	0	0	1	0	0	0	6	0	1	0	0	0	0	0	0	0
	Aug	2	0	0	0	34	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
	Aug	3	0	0	0	17	0	1	0	0	2	0	0	0	0	0	0	0	0	1	1	0	0	2	0	0	0	0	0	0	0	0	0
	Aug	4	0	0	0	4	1	0	0	0	3	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0
CFU	Aug	1	0	0	0	116	0	0	1	0	0	1	0	0	3	0	0	0	0	4	3	0	0	1	1	0	0	0	0	0	0	0	0
	Aug	2	0	0	0	133	0	0	0	0	0	0	0	0	1	0	0	0	0	1	2	1	0	0	2	0	0	1	0	0	0	0	0
	Aug	3	0	1	0	130	0	0	0	0	0	0	0	0	0	0	0	0	1	3	2	1	0	2	0	0	0	0	0	0	0	0	0
	Aug	4	0	0	0	141	0	0	0	0	0	0	0	0	2	0	0	0	0	7	1	0	0	0	0	0	0	0	0	0	0	0	0

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Site	Mon	Rep	Ste	Hya	Gam	Hyd	Sim	Stc	Hem	Cal	Arg	Tro	Hex	Aes	Bae	Hep	Aga	Cla	Dub	Ort	Tan	Chi	Pro	Tip	Ord	Cae	Bra	Och	Lep	Iso	Lar	Tae	Ily
Roth	Sept	1	0	0	0	77	18	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	2	0	0	0	0	0	0	0	0	0
	Sept	2	0	1	0	63	10	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
	Sept	3	0	0	0	64	26	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
	Sept	4	0	0	0	30	10	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0
UHU	Sept	1	0	0	0	17	4	1	0	0	0	0	0	0	5	0	0	0	0	7	2	0	0	1	0	0	0	0	1	0	0	0	0
	Sept	2	0	0	0	14	11	3	0	0	1	0	0	0	10	0	0	0	0	11	4	2	0	3	0	0	0	0	0	0	0	0	0
	Sept	3	0	0	0	12	11	3	0	0	2	0	0	0	3	0	0	0	0	4	3	1	0	1	0	0	0	0	0	0	0	0	0
	Sept	4	0	0	0	20	4	2	0	0	0	0	0	0	0	0	0	0	0	6	1	1	0	0	0	0	0	0	0	0	0	0	0
UHD	Sept	1	0	1	0	20	3	4	1	0	2	0	0	0	0	0	0	0	1	8	1	0	0	1	0	2	0	0	0	0	0	0	0
	Sept	2	0	0	0	27	16	1	0	0	2	0	0	0	3	0	0	0	0	17	8	1	0	1	0	1	0	0	0	0	0	0	0
	Sept	3	0	0	0	28	5	1	0	0	4	0	0	0	9	0	0	0	0	12	6	0	0	1	0	1	0	0	0	0	0	0	0
	Sept	4	0	0	0	5	4	3	0	0	1	0	0	0	11	0	0	0	0	4	1	0	0	1	0	0	0	0	0	0	0	0	0
CFU	Sept	1	0	0	0	106	14	0	0	0	0	0	0	0	14	0	0	0	0	13	6	0	0	0	0	0	0	0	0	0	0	0	0
	Sept	2	0	0	0	87	18	0	0	0	0	0	0	0	13	0	0	0	0	6	9	0	0	0	0	0	0	0	0	0	0	0	0
	Sept	3	0	0	0	66	17	0	0	0	0	0	0	0	16	0	0	0	0	14	7	0	0	1	0	0	0	0	0	0	0	0	0
	Sept	4	0	0	0	140	12	0	0	0	0	0	0	0	23	0	0	0	0	15	10	0	0	0	0	0	0	0	0	0	0	0	0
Roth	Oct	1	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
	Oct	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Oct	3	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
	Oct	4	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
UHU	Oct	1	0	0	1	4	25	1	0	0	0	0	0	0	1	0	0	0	0	13	8	1	0	0	0	0	0	0	0	0	0	0	0
	Oct	2	0	0	0	1	6	1	0	0	0	0	0	0	1	0	0	0	0	7	3	0	0	1	0	0	0	0	0	0	0	0	0
	Oct	3	0	0	0	4	24	1	0	0	0	0	0	0	2	0	0	0	0	16	9	0	0	1	0	0	0	0	0	0	0	0	0
	Oct	4	0	0	0	4	12	0	0	0	1	0	0	0	2	0	0	0	0	19	6	1	0	1	0	0	0	0	0	0	0	0	0
UHD	Oct	1	0	0	1	3	5	3	0	0	1	0	0	0	1	0	0	0	0	15	5	1	0	1	0	0	0	0	0	0	0	0	0
	Oct	2	0	0	0	1	10	1	0	0	0	0	0	0	3	0	0	0	0	21	8	3	0	0	0	0	0	0	0	1	0	0	0
	Oct	3	0	0	0	4	7	2	0	0	0	0	0	0	3	0	0	0	0	17	6	2	0	1	0	0	0	0	1	0	0	0	0
	Oct	4	0	0	1	3	1	1	0	0	2	0	0	0	3	0	0	0	0	14	8	0	0	0	0	0	0	0	1	0	0	0	0
CFU	Oct	1	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	6	4	0	0	0	0	0	0	0	0	0	0	0	0
	Oct	2	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0

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Site	Mon	Rep	Ste	Hya	Gam	Hyd	Sim	Stc	Hem	Cal	Arg	Tro	Hex	Aes	Bae	Hep	Aga	Cla	Dub	Ort	Tan	Chi	Pro	Tip	Ord	Cae	Bra	Ocl	Lep	Iso	Lar	Tae	Ily
	Oct	3	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	2	0	0	0	0	0	0	0	0	0	0	0
	Oct	4	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	2	9	1	0	0	0	0	0	0	0	0	0	0	0
Roth	Nov	1	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	11	11	0	0	1	0	0	0	0	0	0	0	0	0
	Nov	2	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	11	14	1	0	1	0	0	0	0	0	0	0	0	0
	Nov	3	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	10	7	1	0	0	0	0	0	0	0	0	0	0	0
	Nov	4	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	8	5	1	0	1	0	0	0	0	0	0	0	0	0
UHU	Nov	1	0	0	0	1	16	0	0	0	0	0	0	0	0	0	0	0	0	64	32	6	0	0	0	0	0	0	0	0	0	0	0
	Nov	2	1	0	0	2	21	1	0	0	0	0	0	0	0	0	0	0	0	93	47	3	0	1	0	0	0	0	0	0	1	0	0
	Nov	3	0	0	0	2	14	0	0	0	0	0	0	0	0	0	0	0	0	67	31	0	0	0	0	0	0	0	0	0	0	0	0
	Nov	4	0	0	0	0	10	0	0	0	1	0	0	0	0	0	0	1	0	52	43	1	0	2	0	0	0	0	0	0	0	0	0
UHD	Nov	1	0	0	0	2	10	0	0	0	0	0	0	0	2	0	0	0	0	50	14	0	0	0	0	0	0	0	0	0	0	0	0
	Nov	2	0	0	1	2	7	2	0	0	0	0	0	0	0	0	0	0	0	92	18	1	0	0	0	0	0	0	0	0	0	0	0
	Nov	3	1	0	0	1	4	1	0	0	0	0	0	0	0	0	0	0	0	53	23	0	0	0	0	0	0	0	0	0	0	0	0
	Nov	4	1	1	0	4	13	0	0	0	0	0	0	0	0	0	0	0	0	86	27	4	0	1	0	0	0	0	0	0	0	0	0
CFU	Nov	1	0	0	0	19	6	0	0	0	0	0	0	0	0	0	0	0	0	6	12	0	0	0	0	0	0	0	0	0	0	0	0
	Nov	2	0	0	1	22	6	0	0	0	0	0	0	0	0	0	0	0	0	4	8	0	0	0	0	0	0	0	0	0	0	0	0
	Nov	3	0	0	0	26	14	0	0	0	0	0	0	0	0	0	0	0	0	3	6	1	0	0	0	0	0	0	0	0	0	0	0
	Nov	4	0	0	0	5	5	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0	0	0	0	0	0	0	0
Roth	Dec	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	9	16	0	0	0	0	0	0	0	0	0	0	0	0
	Dec	2	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	8	5	0	0	0	0	0	0	0	0	0	0	0	0
	Dec	3	0	0	0	8	2	0	0	0	0	0	0	0	0	0	0	0	0	5	4	1	0	0	0	0	0	0	0	0	0	0	0
	Dec	4	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	12	9	0	0	0	0	0	0	0	0	0	0	0	0
UHU	Dec	1	0	0	0	0	5	0	0	0	1	0	0	0	0	0	0	0	1	61	30	0	0	0	0	0	0	1	0	0	0	0	0
	Dec	2	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	47	36	1	0	0	0	0	0	0	0	0	0	0	0
	Dec	3	0	0	0	0	8	0	0	0	0	0	0	0	1	0	0	0	0	35	38	0	0	1	0	0	0	0	0	0	0	0	0
	Dec	4	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	25	25	0	0	1	0	0	0	0	0	0	0	0	0
UHD	Dec	1	0	2	0	2	2	1	0	0	0	0	0	0	1	0	0	0	0	111	36	0	0	0	0	0	0	0	0	0	0	0	0
	Dec	2	0	1	0	0	5	2	0	0	1	0	0	0	0	0	0	0	0	56	22	1	0	0	0	0	0	0	0	0	0	0	0
	Dec	3	0	0	0	1	6	0	0	0	0	0	0	0	0	1	0	0	0	62	27	0	0	0	0	0	0	0	0	0	0	0	0
	Dec	4	0	0	0	2	10	1	0	0	1	0	0	0	1	0	0	0	0	46	37	1	0	0	0	0	0	0	0	0	0	0	0

Apppendix B Continued. Mascroinvertebrates Collected From Sample Sites on Dry Run Creek.

Site	Mon	Rep	Ste	Hya	Gam	Hyd	Sim	Stc	Hem	Cal	Arg	Tro	Hex	Aes	Bae	Hep	Aga	Cla	Dub	Ort	Tan	Chi	Pro	Tip	Ord	Cae	Bra	Ocr	Lep	Iso	Lar	Tae	Ily
CFU	Dec	1	0	0	0	11	5	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0
	Dec	2	0	0	0	12	2	0	0	0	0	0	0	0	0	0	0	0	0	5	3	0	0	0	0	0	0	0	0	0	0	0	0
	Dec	3	0	1	0	11	6	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0
	Dec	4	0	0	0	7	4	0	0	0	0	0	0	0	0	0	0	0	0	6	5	0	0	0	0	0	0	0	0	0	0	0	0
Roth	Jan	1	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	47	12	2	0	0	0	0	0	0	0	0	0	0	0
	Jan	2	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	49	16	2	0	0	0	0	0	0	0	0	0	0	0
	Jan	3	0	0	0	6	1	0	0	0	1	0	0	0	0	0	0	0	0	41	10	0	0	0	0	0	0	0	0	0	0	0	0
	Jan	4	0	0	0	4	1	0	0	0	0	0	0	0	0	0	0	0	0	40	14	2	0	0	0	0	0	0	0	0	0	0	0
UHD	Jan	1	0	0	4	5	4	19	0	0	0	0	0	0	0	0	0	0	0	262	67	7	0	0	1	3	0	0	0	0	0	0	1
	Jan	2	1	0	0	3	8	9	0	0	0	0	0	0	0	0	0	0	0	348	96	4	0	0	1	3	0	0	0	0	0	1	0
	Jan	3	0	0	1	0	4	4	0	0	0	0	0	0	0	0	0	0	0	180	80	16	0	0	0	0	0	0	0	0	0	0	0
	Jan	4	0	0	0	1	8	6	0	0	1	0	0	0	0	0	0	0	0	236	32	4	0	0	0	2	0	0	0	0	0	0	0
Roth	Feb	1	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	1	39	12	1	0	0	0	0	0	0	0	0	0	0	0
	Feb	2	1	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	34	10	1	0	0	0	0	0	0	0	0	0	0	0
	Feb	3	0	0	0	20	1	1	0	0	0	0	0	0	0	0	0	0	2	47	30	1	0	0	1	0	0	0	0	0	0	0	0
	Feb	4	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	30	16	1	0	0	0	1	0	0	0	0	0	0	0
UHU	Feb	1	0	0	0	4	0	2	0	0	0	0	0	0	0	0	0	0	0	81	20	2	0	0	0	0	0	0	0	0	0	0	0
	Feb	2	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	123	21	4	0	1	0	0	0	0	0	0	0	0	0
	Feb	3	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	70	11	0	0	0	0	0	0	0	0	0	0	0	0
	Feb	4	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	54	20	1	0	1	0	0	0	0	0	0	0	0	0
UHD	Feb	1	0	0	0	4	2	0	0	0	0	0	0	0	0	0	0	0	0	71	11	0	0	0	0	1	0	0	0	0	0	0	0
	Feb	2	0	0	0	8	1	1	0	0	1	0	0	0	0	0	0	0	0	91	19	1	0	0	0	0	0	0	0	0	0	0	0
	Feb	3	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0	0	60	19	2	0	0	0	0	0	0	0	0	0	0	0
	Feb	4	0	0	0	6	3	0	0	0	0	0	0	0	0	0	0	0	0	31	22	0	0	1	0	0	0	0	0	0	0	0	0
Roth	Mar	1	0	0	0	11	1	1	0	0	0	0	0	0	0	0	0	0	0	92	73	2	0	1	0	0	0	0	0	0	0	0	0
	Mar	2	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	59	56	0	0	0	0	1	0	0	0	0	0	0	0
	Mar	3	0	0	0	15	2	0	1	0	0	0	0	0	0	0	0	0	0	55	46	0	0	0	0	0	0	0	0	0	0	0	0
	Mar	4	0	1	0	6	0	0	1	0	0	0	0	0	0	0	0	0	0	56	41	0	0	0	0	0	0	0	0	0	0	0	0
UHU	Mar	1	0	0	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0	88	43	0	0	1	0	0	0	0	0	0	0	0	0
	Mar	2	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	2	0	52	36	3	0	0	0	0	0	0	0	0	0	0	0

Apppendix B Continued. Mascroinvertebrates Collected From Sample Sites on Dry Run Creek.

Site	Mon	Rep	Ste	Hya	Gam	Hyd	Sim	Stc	Hem	Cal	Arg	Tro	Hex	Aes	Bae	Hep	Aga	Cla	Dub	Ort	Tan	Chi	Pro	Tip	Ord	Cae	Bra	Och	Lep	Iso	Lar	Tae	Ily
	Mar	3	0	0	0	3	4	0	0	0	0	0	0	0	0	0	0	0	0	79	59	6	1	0	0	0	0	0	0	0	1	0	0
	Mar	4	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	56	53	1	0	0	0	0	0	0	0	0	0	0	0
UHD	Mar	1	0	0	0	5	0	1	0	0	0	0	0	0	0	0	0	0	1	38	25	1	0	0	0	0	0	0	0	0	0	0	0
	Mar	2	0	0	0	4	1	0	1	0	0	0	0	0	0	0	0	0	0	25	38	1	1	1	0	0	0	0	0	0	0	0	0
	Mar	3	0	1	0	3	1	1	0	0	0	0	0	0	0	0	0	0	0	27	19	2	1	0	0	0	0	0	0	0	0	0	0
	Mar	4	0	0	0	4	0	1	2	0	0	0	0	0	0	0	0	1	0	17	14	1	1	2	0	0	0	0	0	0	0	0	0
Roth	Apr	1	0	0	0	9	1	0	1	0	0	0	0	0	29	0	0	1	0	66	17	0	0	0	0	0	0	0	0	0	0	0	0
	Apr	2	0	0	0	3	2	0	1	0	0	0	0	0	30	0	0	0	0	101	30	2	0	0	0	0	0	0	0	0	0	0	0
	Apr	3	0	0	0	8	0	0	2	0	0	0	0	0	47	0	0	0	0	116	51	0	0	0	0	0	0	0	0	0	0	0	0
	Apr	4	0	0	3	12	4	0	0	0	0	0	0	0	44	0	0	1	0	78	24	2	0	0	0	0	0	0	0	0	0	0	0
UHU	Apr	1	0	0	0	2	3	1	3	0	0	0	0	0	0	0	0	2	0	66	25	3	0	0	0	0	0	0	0	0	0	0	0
	Apr	2	0	0	1	0	5	0	0	0	0	0	0	0	3	0	0	0	0	91	28	1	0	0	0	0	0	0	0	0	0	0	0
	Apr	3	0	0	0	2	17	0	0	0	0	0	0	0	7	0	0	0	0	83	29	3	0	0	0	0	0	0	0	0	0	0	0
	Apr	4	0	0	0	1	13	1	0	0	0	0	0	0	10	0	0	0	0	61	35	3	0	1	0	0	0	0	0	0	0	0	0
UHD	Apr	1	0	0	0	1	2	0	0	0	0	0	0	0	1	0	0	1	0	17	9	0	10	0	0	0	0	0	0	0	0	0	0
	Apr	2	0	0	0	1	2	0	1	0	0	0	0	0	3	0	0	0	0	36	16	2	11	1	1	0	0	0	0	0	0	0	0
	Apr	3	0	0	0	2	2	0	1	0	1	0	0	0	1	0	0	0	0	24	17	0	12	0	0	1	0	0	0	0	0	0	0
	Apr	4	0	0	0	3	2	1	2	0	0	0	1	0	1	0	0	0	0	57	28	0	2	0	1	0	0	0	0	0	0	0	0

Ste = Stenelmis
Hya = Hyalella
Gam = Gammarus
Hyd = Hydropsyche
Sim = Simulium
Stc = Stenacron
Hem = Hemerodromia
Cal = Calopteryx
Arg = Argia
Tro = Tropisternus

Hex = Hexatoma
Aes = Aeshnidae
Bae = Baetis
Hep = Heptagenia
Aga = Agabinus
Cla = Claassenia
Dub = Dubiraphia
Ort = Orthocladiinae
Tan = Tanypodinae
Chi = Chironominae

Pro= Probezzia
Tip = Tipula
Ord = Ordobrevia
Cae = Caenis
Bra = Brachycentrus
Och = Ochrotrichia
Lep = Leptophlebia
Iso = Isonychia
Lar = Lara
Tae = Taeniopteryx

Ily = Ilybius